MP15DC

LOCOMOTIVE SERVICE MANUAL

ELECTRO-MOTIVE

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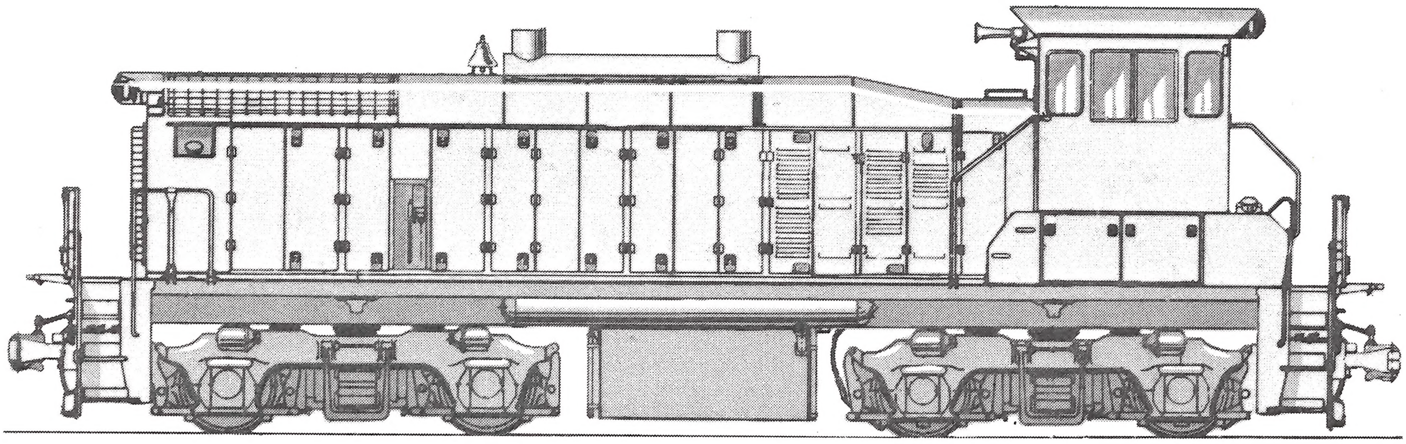
2nd. Edition

November 1980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ELECTRO-MOTIVE

A Service Department Publication

Electro-Motive Division Of General Motors La Grange, Illinois 60525

FOREWORD

This manual covers mechanical and electrical maintenance. Its purpose is to provide instructions for what may be called "on-the-locomotive" maintenance, and to provide under separate cover material for general familiarization with locomotive components and systems. The material included is applicable to the basic locomotive and common extra equipment. The presence or absence of coverage for any particular system or component in no way implies that the equipment is or is not part of any specific locomotive.

Instructions for maintenance that requires deep involvement with component repair, or instructions for rework that involves use of bench apparatus, will be presented in the standard EMD Maintenance Instruction form and in manufacturer's publications covering special equipment.

Instructions covering the diesel engine appear in the EMD Engine Maintenance Manual. Certain engine mounted equipment may receive brief mention in this locomotive service manual, but information in the engine maintenance manual covering such equipment takes precedence.

SERVICE DATA PAGES

A Service Data page is included at the back of some sections of the Locomotive Service Manual. This page provides the following:

1. Reference to applicable Maintenance Instructions and technical manuals.

2. Reference to applicable tool and testing apparatus numbers.

3. Specific system values for operation or testing.

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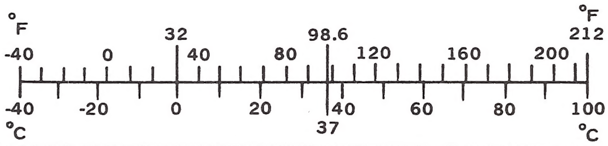
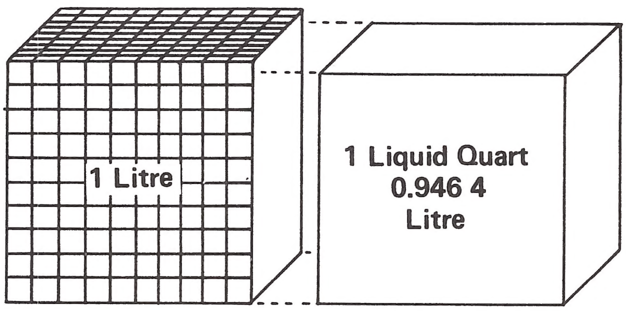
METRIC CONVERSION

TABLE OF FREQUENTLY USED UNITS

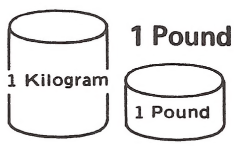
Multiply	by	to get equivalent number of:
LENGTH		
Microinch	.025 4	micron (μ)
Inch	25.4	millimetres (mm)
Foot	0.304 8	metres (m)
Yard	0.914 4	metres
Mile	1.609	kilometres (km)
AREA		
Inch^2	645.2	millimetres^2 (mm^2)
	6.45	centimetres^2 (cm^2)
Foot^2	0.092 9	metres^2 (m^2)
Yard^2	0.836 1	metres^2
VOLUME		
Ounce	29.574	centimetre^3 (cm^3)
Inch^3	16 387.	mm^3
	16.387	cm^3
	0.016 4	litres (l)
Ft^3	0.028 3	metre^3 (m^3)
Quart	0.946 4	litres
Gallon	3.785 4	litres
Yard^3	0.764 6	metres^3 (m^3)
MASS		
Ounce	28.350	grams (g)
Pound	0.453 6	kilograms (kg)
Ton	907.18	kilogram
Ton	0.907	tonne (t)
FORCE		
Kilogram	9.807	newtons (N)
Ounce	0.278	newtons
Pound	4.448	newtons
TEMPERATURE		
Degree Fahrenheit	(t° F-32)÷1.8	degree Celsius (C)



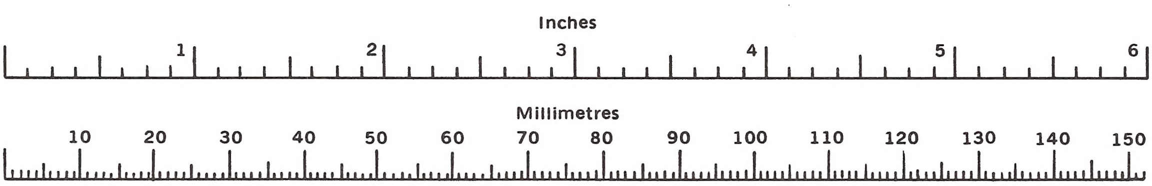
Multiply	by	to get equivalent number of:
ACCELERATION		
Foot/sec^2	0.304 8	metre/sec^2 (m/s^2)
Inch/sec^2	0.025 4	metre/sec^2
TORQUE		
Ounce-force-inch	0.007 06	newton-metre
	0.069 2	kilogram-metre
Pound-inch	0.112 98	newton-metres (N·m)
	0.011 52	kilogram-metres
Pound-foot	1.355 8	newton-metres
	0.138 25	kilogram-metres
POWER		
Horsepower	0.746	kilowatts (kW)
PRESSURE OR STRESS		
Inches of water	0.249 1	kilopascals (kPa)
Pounds/sq. in.	6.895	kilopascals
ENERGY OR WORK		
BTU	1 055.	joules (J)
Foot-pound	1.355 8	joules
Kilowatt-hour	3 600 000 or 3.6x10^6	joules (J = one W's)
LIGHT		
Footcandle	10.764	lumens/metre^2 (lm/m^2)
FUEL PERFORMANCE		
Miles/gal	0.425 1	kilometres/litre (km/l)
Gal/mile	2.352 7	litres/kilometre (l/km)
VELOCITY		
Miles/hour	1.609 3	kilometres/hr. (km/h)



The comparative dimensions of an inch and a millimeter, a litre and a quart, and a kilogram and a pound are shown.



1 Pound = 0.453 6 kg



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ELECTRO-MOTIVE

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GENERAL INFORMATION

Model Designation	MP15DC
Locomotive Type	(B-B) 0440
Locomotive Power	1119 kW (1500 HP)
Approximate Weight On Rails	112 493 kg (248,000 lbs.)
Diesel Engine	
Model	645E
Operating Principle	Two Stroke Cycle, Blower Aspirated, Unit Injection, Water Cooled
Number Of Cylinders	12
Cylinder Arrangement	45° "V"
Compression Ratio	16:1
Rotation (Facing Flywheel End)	Counterclockwise
Bore And Stroke	9-1/16" x 10"
Idle Speed (Normal)	318 RPM
Low Idle Speed	235 RPM
Idle - Switching 2 Mode	517 RPM
Full Speed	904 RPM
Main Generator	
Model	D32
Maximum Continuous Current	2350
Nominal Voltage, DC	600
Auxiliary Generator	
Model - Basic	A-7159
Voltage DC	74
Rating	10 kW
Model - Extra	A-8102
Voltage DC	74
Rating	18 kW
Air Compressor	
Type	Water Cooled
Number Of Cylinders	
Basic - Model WBO	3
Special - Model WBG	6
Lube Oil Capacity - Nominal	
3-Cylinder Model	38 Litres (10 Gal.)
6-Cylinder Model	68 Litres (18 Gal.)
Compressor Displacement At 900 RPM	
3-Cylinder Model	7.2 m^3/Minute (254 Cu. Ft./Min.)
6-Cylinder Model	11.3 m^3/Minute (400 Cu. Ft./Min.)

Storage Battery

Model	MS280
Number Of Cells	32
Voltage	64
Rating (8-Hour)	284 Ampere Hr.

Traction Motors

Model	D77
Type	Direct current, series wound, axle hung with rubber nose suspension to damp torque shock.

Maximum Continuous Current Rating	920 with 62:15 Gearing
Minimum Continuous Speed At Full Horsepower	15.0 km/H (9.3 MPH)
Maximum Speed	104.6 km/H (65 MPH)
Maximum Speed At Which Full Power Is Available	
No Shunt	34.6 km/H 21.5 MPH
Shunt	66.8 km/H 41.5 MPH

Model	4-Wheel – Clasp Brake
Wheel Diameter	1016 mm (40″)
(Index groove provided for wheel diameter control)	
Rim	63.5 mm (2-1/2″)

Basic Journal Boxes	165 mm x 305 mm (6-1/2″ x 12″) roller bearing with lateral thrust taken up by cushioning directly by the box.

Dimensions

Between Bolster Centers	7.366 m (24′ 2″)
Truck Wheel-Base	2.743 m (108″)

Curve Negotiation Capability

32.614 m (107 Ft.) Radius - 55° Curve –	Represents minimum single unit curve negotiation for a basic clasp brake truck as limited by truck swing.
33.528 m (110 Ft.) Radius - 54° Curve –	Represents minimum curve capability for two MP15DC units in multiple as limited by coupler swing.
60.960 m (200 Ft.) Radius - 29° Curve –	Represents minimum curve capability of an MP15DC coupled to a standard 15.24 m (50′) box car as limited by coupler swing.

Supplies	
Lube Oil Capacity	
Basic Oil Pan	746 Litres (197 Gal.)
Increased Capacity Oil Pan	1 075 Litres (284 Gal.)
Usable Oil	
(Volumn between "Full" And "Low" on dipstick)	
Basic Oil Pan	254 Litres (67 Gal.)
Increased Capacity Oil Pan	481 Litres (127 Gal.)
Fuel Capacity	
Basic	4 164 Litres (1100 Gal.)
Special Available	5 300 Litres (1400 Gal.)
Cooling System Capacity	871 Litres (230 Gal.)
Sand Capacity	
Basic	0.849 m^3 (30 Cu. Ft.)
Special	1.133 m^3 (40 Cu. Ft.)

Major Dimensions	
Distance between bolster centers	7.366 m (24′ 2″)
Distance, pulling face front coupler to rear coupler	14.834 m (48′ 8″)
Width over the underframe	3.277 m (10′ 3/4″)
Height, top of rail to top of cab	4.572 m (15′)

WEIGHTS

The weights as listed below are approximate and are intended as an aid in determining the handling procedure to be used. Weights represent lbs per unit as described.

	kg	lbs.
12-645E Diesel Engine	11 512	25,380
Engine Governor	54	120
D32 Main Generator Assembly	6 541	14,420
Auxiliary Generator And Blower Assembly	454	1000
Fuel Tank 4 164 Litres (1100 Gal.)	1 572	3465
Fuel Tank 5 300 Litres (1400 Gal.)	1 823	4018
Truck Assembly	17 917	39,500
Traction Motor	2 722	6000
Axle And Wheel Set With Gear	1 882	4150
Wheel	460	1015
Gear 62 Tooth	186	409
Bearing – Inner Race	15	33
Air Compressor	1 055	2325
Air Compressor Shaft	62	136
Air Compressor Shaft Guard	31	68
Air Compressor Coupling	22	48
Lube Oil Cooler	383	845
Lube Oil Filter	306	675
Fuel Pump Assembly	37	81
Fuel Suction Strainer	4	8
Fuel Filter	27	60
Temperature Switch Manifold	9	20
Load Regulator Vane Motor	16	36
Radiator Core	147	325
Storage Battery	92	202

GENERAL DESCRIPTION

The diesel engine operates on a two-stroke cycle, with power applied on each downward stroke. At the bottom of each downward stroke cylinders are aspirated through cylinder wall ports opening to a chamber that is supplied with pressurized air from a rotary blower. The pressurized air scavenges spent gases from the cylinder through multiple exhaust valves in the cylinder head. As the piston moves upward the ports are closed off and the exhaust valves close. Air is compressed in the cylinder. At the top of the stroke fuel is injected into the cylinder and ignited by heat of compression to provide power to drive the piston downward until the cylinder wall ports and the exhaust valves again open.

The exhaust gases from the cylinder pass through spark arresting manifolds before leaving through the locomotive stacks.

An engine mounted gear driven centrifugal pump supplies coolant to engine manifolds connected to cylinder heads and liner jackets. A coolant return manifold encloses cylinder exhaust ducts. Heated coolant is piped from the engine through the radiators, and through an oil cooler before it returns to the centrifugal pumps.

The entire system is pressurized, with pressure level maintained by a relief valve at the storage tank cap. A low water pressure detector is connected to the discharge side of the centrifugal pumps to bring about engine shutdown should pump pressure fail.

Automatic temperature control is accomplished by a temperature sensing switch flange mounted on a manifold connected to the discharge side of the pump. The switch controls a magnet valve that supplies compressed air to the fan shutter operating piston. A high temperature switch in the manifold operates to sound an alarm when engine temperature exceeds a predetermined maximum. The coolant storage tank is provided with a "rattlesnake" type fill pipe equipped with a manually operated valve, the handle of which interlocks with the pressure cap handle to ensure release of system pressure before pressure cap removal is possible.

A positive displacement gear type scavenging oil pump draws oil from the engine sump and through a strainer, then pumps it through filters and a cooler to a second strainer chamber. A dual piston-cooling and lubricating oil pump receives oil from the second strainer and delivers it to engine manifolds for engine lubrication and piston cooling.

Engine fuel is drawn from the underframe mounted tank through a wire mesh suction strainer to a gear type DC motor driven pump. The pump forces fuel through engine mounted fuel filters which provide filtration before the fuel reaches the fuel injectors located at each cylinder. Excess fuel not used by the injector provides cooling before being returned to the tank.

Fuel injectors supply a precisely metered quantity of atomized fuel to the engine cylinders at a precise moment in the firing cycle. The engine governor operates injector gear racks to maintain the proper amount of fuel needed for engine speed and power level called for.

LOCOMOTIVE OPERATION

1. The fuel pump is driven by an electric motor which, for fuel priming, uses current from the storage battery. Once the engine is started and running, the fuel pump motor uses current directly from the auxiliary generator. The fuel pump transfers fuel from the fuel tank under the locomotive to the engine injectors.

2. The diesel engine is started by means of the direct coupled main generator which is temporarily used as a starting motor. A storage battery supplies the electric current to rotate the generator for starting the engine.

3. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive two electrical generators, an air compressor, and a combination generator and traction motor blower assembly. Cooling air for the engine radiators is provided by a fan that is driven by a set of "V" belts.

4. The auxiliary generator charges the storage battery and supplies low voltage direct current for the control, lighting and main generator excitation circuits. The main generator supplies high voltage direct current to the traction motors for locomotive pulling power.

5. By means of cab controls, low voltage circuits are established to actuate the engine governor and electrical switchgear.

6. Four traction motors are located under the locomotive. Each traction motor is directly geared to an axle and a pair of driving wheels. These motors are located in the two trucks which support the locomotive weight and distribute it to the driving wheels.

7. The throttle electrically controls speed and power by actuating a governor mounted on the engine. The main generator converts the engine's mechanical power to electrical power, which is then distributed to the traction motors through circuits established by the various switchgear components in the electrical cabinet.

8. A load regulator prevents the engine from being over or underloaded by regulating the electrical load on the engine in all throttle positions.

9. The air compressor supplies air under pressure to the main reservoirs which is used primarily for the air brakes. The air brakes are controlled by the operator through suitable equipment in the cab.

10. Except for manual operation of the cab controls, the locomotive operation is completely automatic. Various alarms and safety devices will alert the operator should any difficulties occur.

ELECTRICAL REFERENCE DESIGNATIONS

In the following general legend of reference designations, the long dash "–" means that a numeral or numerals will appear when the designation is used in a specific wiring diagram. The symbols appear in alpha/numeric order with letters of the alphabet taking first position followed by numerals (represented by the long dash "–"). The list is general, and all of the reference designations do not necessarily appear on a given wiring diagram.

AV, BV, CV, DV	Governor Speed Setting Solenoids
BATT	Storage Battery (64 VDC)
BF	Battery Field Contactor
CA–	Capacitor
CCR	Compressor Control Relay
CCS	Compressor Control Switch
CR–	Rectifier
CR-BC	Battery Charging Rectifier
CR-GR	Ground Relay Rectifier
CRL	Compressor Relay
EBT	Electric Blowdown Timer
ER	Engine Run Relay
ESS	Emergency Sanding Switch
ETR	Engine Temperature Relay
ETS	Engine Temperature Switch
FOR	Forward Directional Relay
FP	Fuel Pump
FPC	Fuel Pump Contactor
FP-ES	Fuel Prime - Engine Start Switch
FPR	Fuel Pump Relay
FSR	Field Shunt Relay
FS	Field Shunt Contactor
GFR	Generator Field Relay
GR	Ground Relay
GS	Generator Starting Contactor
IS	Isolation Switch
LR	Load Regulator
LTS	Lights
MCO–	Motor Cutout Switch
MSS	Manual Sanding Switch
MV-CC	Compressor Control Magnet Valve
MV-SH	Shutter Control Magnet Valve
MV-818 -824 -880	Filter Blowdown Magnet Valves
MV– -SF	Forward Sanding Magnet Valve
MV– -SR	Reverse Sanding Magnet Valve
ORS	Overriding Solenoid
P–	Power Contactor
RE–	Resistor
RE-BC	Battery Charging Resistor
RER	Reverse Directional Relay
RHS	Reverser Handle Switch
RH–	Rheostat
RVF	Transfer Switch Forward Relay
RVR	Transfer Switch Reverse Relay
SSS	Service Selector Switch
STS	Shutter Control Temperature Switch
TB	Terminal Board
THS	Throttle Handle Switch
VR–	Voltage Regulator
WSR	Wheel Slip Relay
WSR–	Wheel Slip Bridge Relay

ELECTRO-MOTIVE

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SECTION 1

FUEL SYSTEM AND ENGINE STARTING

DESCRIPTION

A pictorial diagram of the fuel oil system is shown in Fig. 1-1. Fuel is drawn from the storage tank through a suction fuel strainer by the motor driven gear type fuel pump.

From the pump the fuel is forced through a double element fuel filter mounted on the engine. After passing through the filter, the fuel flows through manifolds that extend along both banks of the engine.

These manifolds supply fuel to the injectors. The excess fuel not used by the injectors returns to the fuel tank through the return fuel sight glass mounted on the filter housing. A restriction inside the return glass causes back pressure, thus maintaining a positive supply of fuel for the injectors.

The fuel pump delivers more fuel to the engine than is burned in the cylinders. The excess fuel circulated is used for cooling and lubricating the fine working parts of the injectors.

A 172 kPa (25 psi) bypass valve is connected across the primary filter. If the primary filter becomes plugged, fuel will bypass and impose the total filtering load on the engine mounted filter.

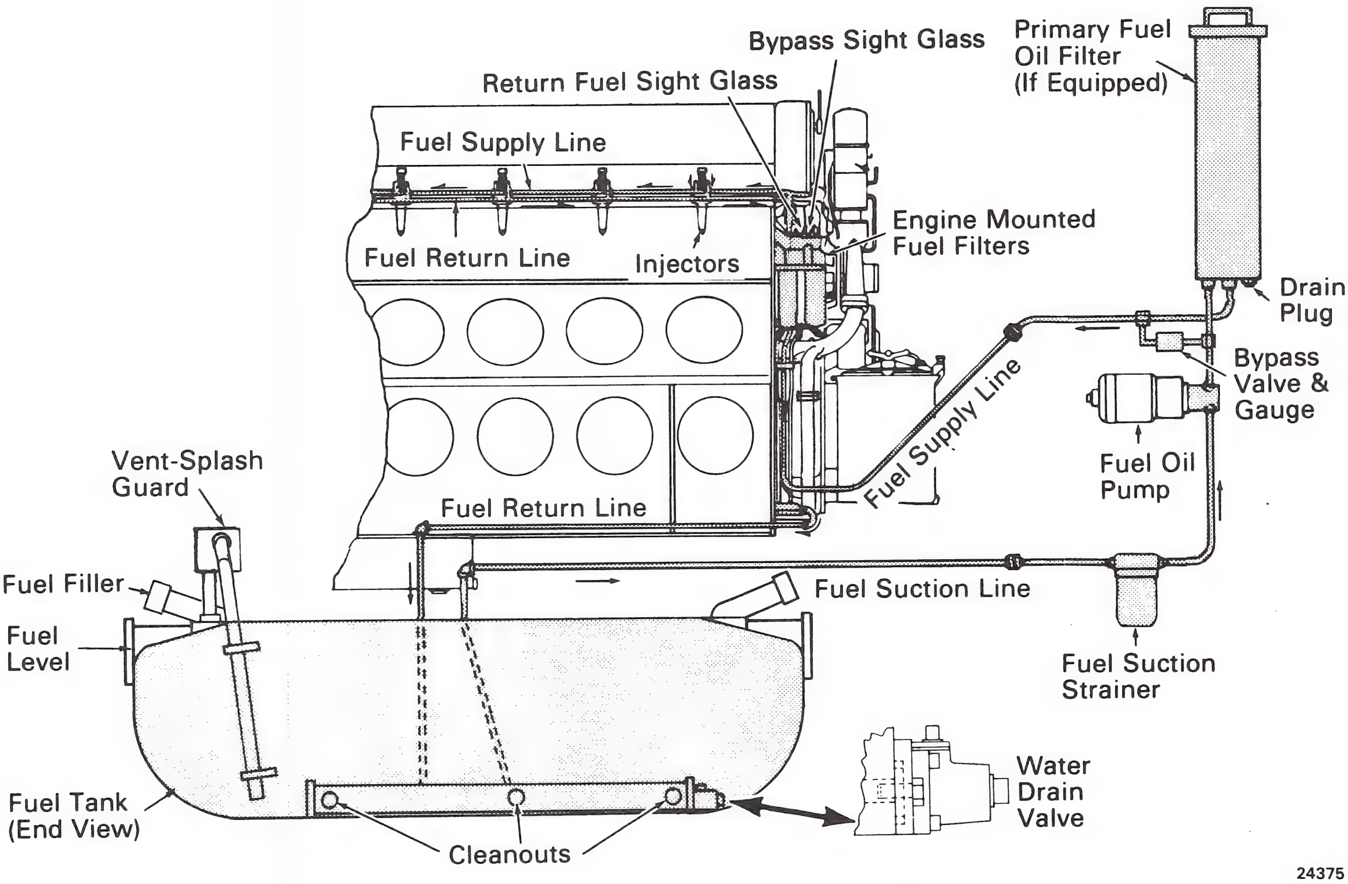

Fig.1-1 – Fuel Oil System, Pictorial Diagram

FUEL SIGHT GLASSES

Two sight glasses, Fig. 1-2, are located on the engine mounted filter housing to give visual indication of fuel system condition.

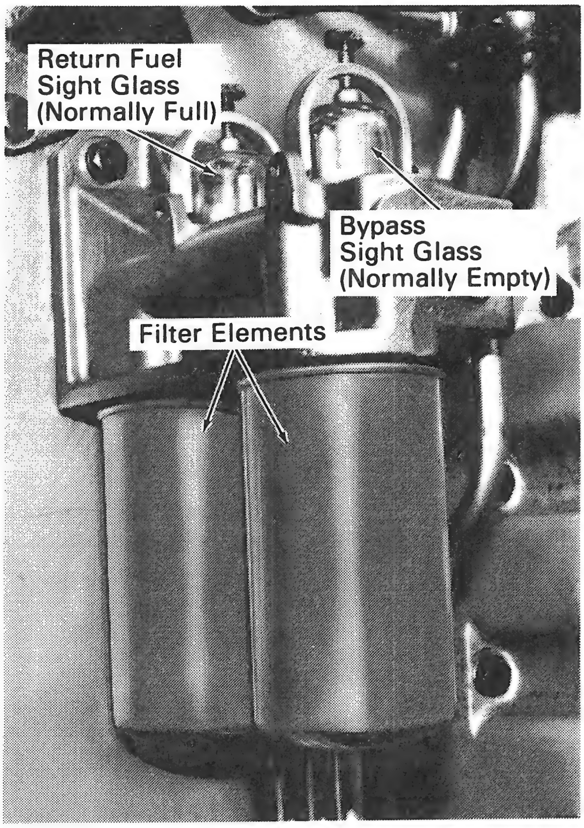

Fig. 1-2 – Engine Mounted Fuel Filters With Sight Glasses

For proper engine operation the return fuel sight glass (the glass nearer the engine) should be full, clear, and free of bubbles. The fuel flowing through this glass is the excess not required by the engine. Upon leaving the glass it returns to the fuel tank for recirculation.

At the time of engine start the sight glass will be empty. When the fuel system is primed, turbulent flow will occur and when the fuel in the glass flows clear and free of bubbles the engine may be cranked.

The engine mounted filter is also equipped with a bypass relief valve and sight glass. This sight glass, farther from the engine, is normally empty. When more than a trickle of fuel is seen in the bypass sight glass, it indicates that the relief valve is open. Fuel will pass through the bypass sight glass and relief valve to bypass the engine and return to the fuel tank when the filter elements become clogged. This condition may become serious and cause the engine to shut down from lack of fuel.

EMERGENCY FUEL CUTOFF SWITCHES

In the event of an emergency, the fuel supply to the engine can be stopped by pressing on any one of the three emergency fuel cutoff switches. Two switches, one on either side of the locomotive, are located on the underframe in the vicinity of the fuel filler, and the third switch is located on the engine control panel. The switches are connected in series with the fuel pump control relay FPC. Pressing in on any of the switch buttons, momentarily, will de-energize the FPC, stop the fuel pump, and shut down the engine. The buttons are spring loaded and do not need to be reset. See the fuel pump circuit drawing at the end of this section.

MAINTENANCE

FUEL STORAGE FACILITIES

Effective wayside fuel filtration is necessary to ensure cleanliness, quality, and uniformity of the fuels supplied to the engine fuel tanks. This is especially true since 1974, due to a general decrease in fuel cleanliness resulting from more frequent fuel turnover (shortened storage tank settling time), and reduced fuel inventories (which can result in increased agitation of tank bottoms during filling).

Fuel contaminants can be classified into two categories; soft or deformable, and hard. Soft contaminants include micro-organisms (such as bacteria and algae), waxes, and water. Hard contaminants include rust, scale, cracking catalyst fines, dirt, and wear metals.

Soft contaminants such as waxes generally are kept in suspension and do not normally cause trouble. However, both water and micro-organisms are detrimental to fuel system components. The presence of slime on fuel filters indicates that bacteria and fungi are present in troublesome quantities. The effects of water in fuel are well known, and it is recognized that water must be removed or kept at the lowest possible level.

Electro-Motive strongly recommends the utilization of wayside fuel filtration facilities that will efficiently remove water and contaminants 2 micron size and larger, and provide fuel that meets the cleanliness specifications given in the applicable Maintenance Instruction.

DRAINING CONDENSATE FROM THE FUEL TANK

Condensate should be drained from the locomotive fuel tank at the intervals stipulated in the Scheduled Maintenance Program, or more frequently if conditions warrant. During draining, the locomotive should be placed on an incline with the drain end of the tank facing downhill to facilitate condensate drainage. A ball valve drain, Fig. 1-1, is provided for this purpose. To drain, simply remove the pipe plug and position flow indicator to "open."

FILLING THE FUEL TANK

The fuel tank can be filled from either side of the locomotive. A short sight level gauge is located next to each fuel filler. This gauge indicates the fuel level from the top of the tank to about 114 mm (4-1/2") below the top and should be observed while filling the tank to prevent overfilling. DO NOT HANDLE FUEL OIL NEAR AN OPEN FLAME.

The basic filler cap assembly, Fig. 1-3, is equipped with a strainer. Periodically inspect the fuel strainer and test the relief cap for operation against the spring. Also check the condition of the filler cap gasket.

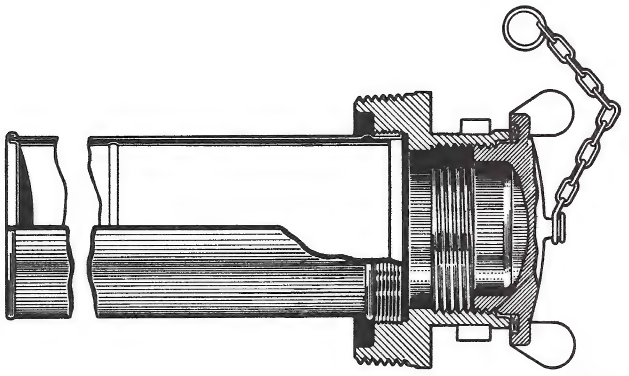

Fig. 1-3 – Fuel Filler Assembly

PRIMARY FUEL SUCTION STRAINER, Fig. 1-4

The fuel suction strainer should be cleaned and inspected at the intervals stated in the Scheduled Maintenance Program or at shorter intervals if operating conditions warrant.

CLEANING PROCEDURE

1. Stop the diesel engine, and place the fuel pump circuit breaker in the OFF position.

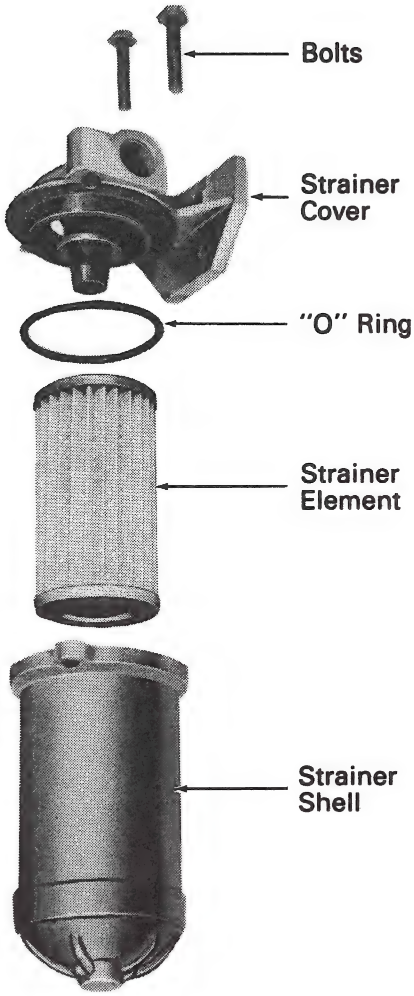

Fig. 1-4 – Fuel Suction Strainer, Exploded View

2. Remove the bolts holding the strainer shell to the strainer cover, and remove the shell and strainer from the cover. To prevent loss, thread the bolts with washers into the strainer shell threaded openings.

3. Withdraw the wire mesh strainer element, discard the oil and sediment held in the strainer shell.

4. Clean the wire mesh element in a container of clean fuel oil. A brush may be used and a round wooden dowel employed to spread the pleats and determine the degree of cleanliness, but no special tools are necessary.

CAUTION

Chlorinated hydrocarbon solvents and temperatures above 82° C (180° F) will damage the epoxy material bonding the strainer element to the end caps.

5. Clean the shell with fuel oil and wipe clean. Note that the spring in the bottom is spot welded to the shell.

6. Inspect the housing-to-cover "O" ring, and replace with a new ring if necessary.

7. Place the cleaned strainer element in the shell and reapply the shell to the strainer cover. Tighten firmly into place after making certain the "O" ring is properly seated.

PRIMARY FUEL FILTER, Fig. 1-5 (Special Order)

The primary fuel filter element should be changed at the intervals stated in the Scheduled Maintenance Program or at shorter intervals if operating conditions warrant.

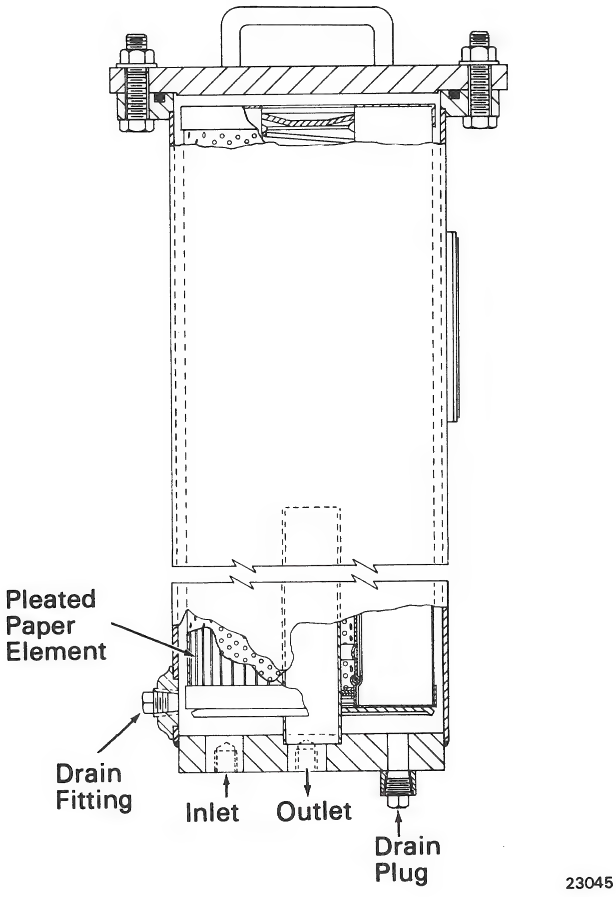

Fig.1-5 - Primary Fuel Filter And Housing

CLEANING PROCEDURE

1. Stop the diesel engine; place isolation switch in ISOLATE position.

2. Place a container which will hold approximately 19 litres (5 gallons) under the filter housing to catch fuel drainage, and remove drain plug.

NOTE

If the pipe plug or the filter cover are opened shortly after engine shutdown, pressure retained in the system will cause fuel to spurt out of the opening.

3. Loosen the filter cover plate retaining nuts, then twist the cover and remove it. Withdraw and discard the pleated paper filter element.

4. Place the fuel prime switch in FUEL PRIME position to introduce a flow of fuel and wash out any sediment that may be held at the base of the filter housing.

5. Insert a new filter element into the housing, being careful not to damage the lower seal on the filter element.

6. Inspect the filter housing cover gasket and replace with a new gasket if necessary. Replace the housing cover and firmly tighten the retaining bolts.

7. Tighten drain plug securely.

8. Operate the fuel prime switch until fuel runs free and clear of bubble in the return fuel sight glass. Check for leakage at the drain plug and the housing cover.

PRIMARY FUEL FILTER BYPASS VALVE AND GAUGE, Fig. 1-6 (Special Order)

This gauge only indicates the condition of the primary fuel filter. Increased pressure differential across the primary fuel filter will be indicated by a numerically greater pressure reading on the gauge. Normally, with a new primary filter, the gauge should read zero lbs. When the indicator on the

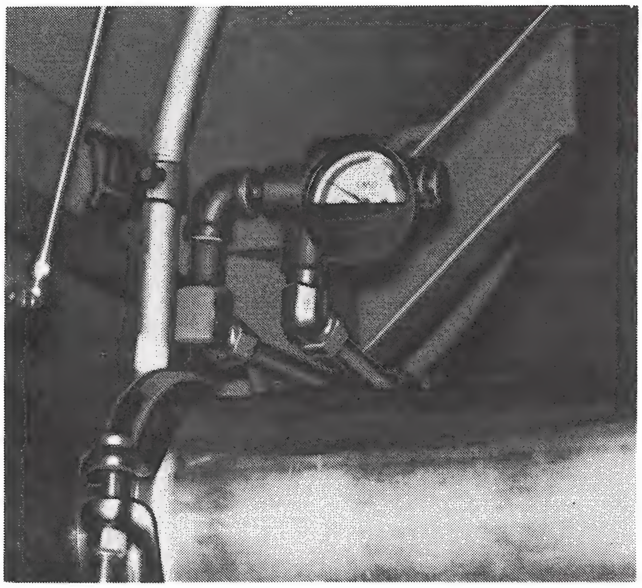

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Fig. 1-6 – Bypass Valve And Gauge

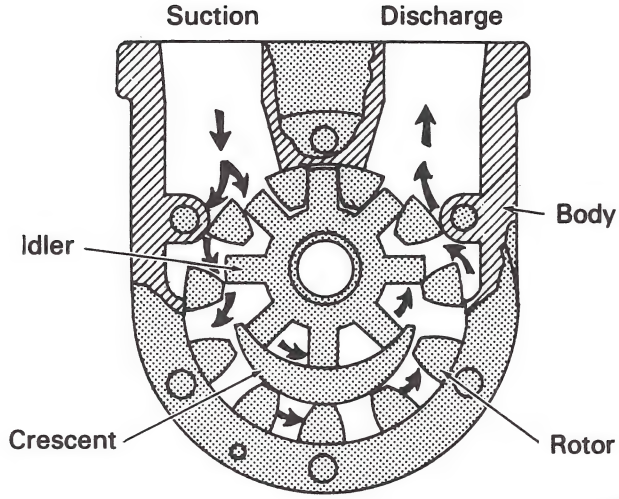

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Fig. 1-7 – Fuel Pump Cross-Section

gauge reaches 69 kPa (10 lbs), two-thirds of the primary filter element has been used. Renew the primary filter element when pressure differential reaches 138 kPa (20 psi) or more. At 172 kPa (25 psi) the fuel will start to bypass the primary fuel filter.

ENGINE MOUNTED FUEL FILTERS

The engine mounted fuel filters should be changed at the intervals stipulated in the Scheduled Maintenance Program and the filter assembly should be maintained in accordance with the instructions in the Engine Maintenance Manual.

1. Shut down the engine.
2. Unscrew and discard the elements. Use a strap wrench if necessary.
3. Clean the filter assembly and sight glasses.
4. Apply a film of oil to the element gaskets.
5. Apply the elements to the filter body. Hand tighten until the gasket contacts the filter body, then tighten one-half turn.
6. Check for leaks after the engine is started.

FUEL PUMP AND MOTOR

The motor driven fuel pump, Fig. 1-7, is mounted on the equipment rack. It is an "internal" gear pump driven by battery power during system priming and by power from the auxiliary generator during operation.

Fuel is drawn into the inlet portion to fill a space created by the gear teeth coming out of mesh. The fuel is then trapped in the space between the gear teeth and carried to the outlet side of the pump. There the gears mesh, forcing the fuel from between the gear teeth and through the outlet.

The fuel pump and motor need no routine maintenance if operation is satisfactory. However, the motor and pump should be reconditioned in accordance with EMD Maintenance Instruction listed on the Service Data page. Maintenance should be performed at the intervals stipulated in the Scheduled Maintenance Program.

CAUTION

Use care during washing of the engineroom to protect the fuel pump motor from water. Water in the motor can cause an electrical ground.

FUEL PUMP CIRCUIT (MU)

When locomotive control circuits are established, and the control and fuel pump switch on the control stand is closed, the fuel pump relay FPR, Fig. 1-8, is energized. This establishes a circuit that provides the operator with the means of shutting off the fuel pump from a switch on the control stand. However, before the engine is running, the fuel pump relay performs no function.

With the control circuits established, the No. 11 contact of the Fuel Prime/Engine Start switch FP/ES is energized. Power is supplied through two sets of switch contacts to the fuel pump motor when FP/ES is held in the FUEL PRIME position.

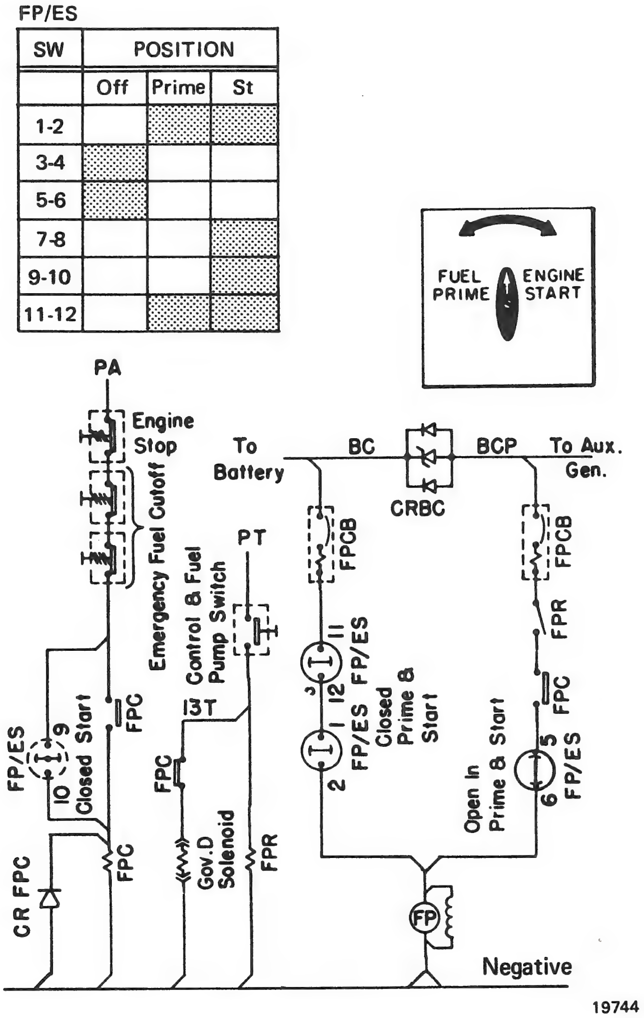

Fig.1-8 – Fuel Pump Circuit (MU)

After the system is primed and fuel flows free and clear in the return fuel sight glass, the FP/ES is rotated to the START position. The fuel pump contactor FPC is energized through the 9-10 contacts of the FP/ES and held in by a set of FPC contacts. Other contacts of the FP/ES cause engine cranking from the main generator starting circuit.

The battery continues to power the fuel pump motor until the engine starts and the FP/ES is released. The auxiliary generator will then supply power to the fuel pump motor.

The fuel pump motor will stop if either the fuel pump relay FPR or the fuel pump contactor FPC is de-energized. However, de-energizing FPR will not immediately stop the engine. De-energized FPC is required for immediate withdrawal of injector racks and engine shutdown due to pickup of the governor D solenoid.

FUEL PUMP CIRCUIT (BASIC)

When locomotive control circuits are established and the control and fuel pump switch on the control stand is closed, Fig. 1-9, the No. 11 contact of the Fuel Prime/Engine Start switch FP/ES is energized. Power is supplied through two sets of switch contacts to the fuel pump motor when FP/ES is held in the FUEL PRIME position.

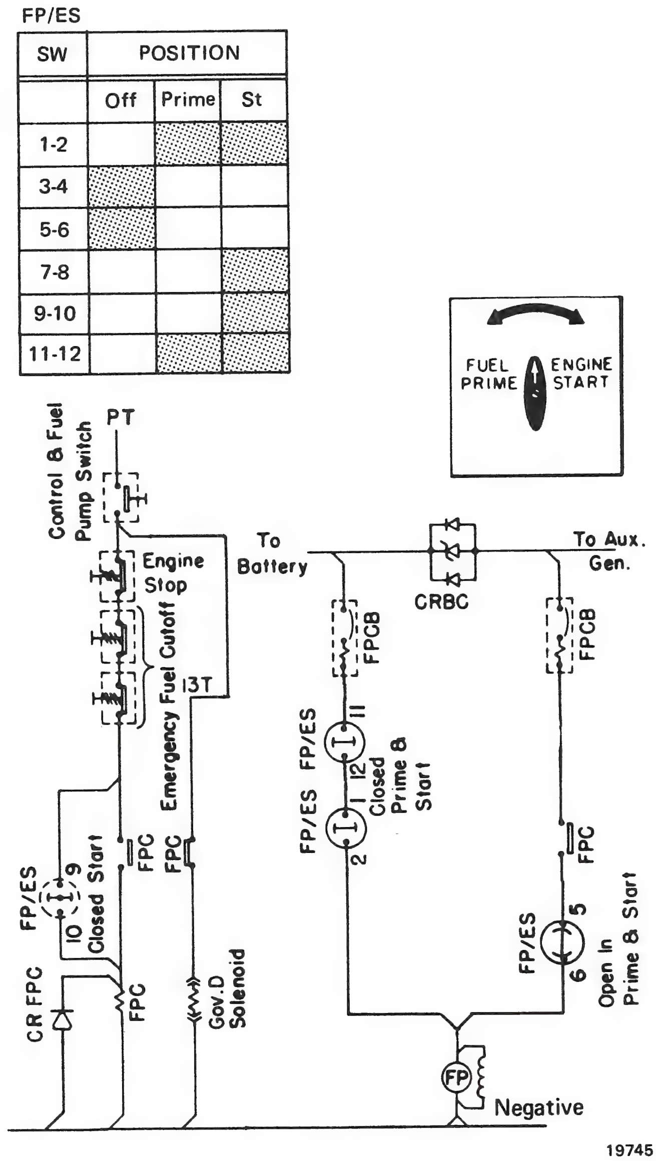

Fig.1-9 – Fuel Pump Circuit (Basic)

After the system is primed and fuel flows free and clear in the return fuel sight glass, the FP/ES is rotated to the START position. The fuel pump contactor is energized through the 9-10 contacts of the FP/ES and held in by a set of FPC contacts. Other contacts of the FP/ES cause engine cranking from the main generator starting circuit.

The battery continues to power the fuel pump motor until the engine starts and the FP/ES is released. The auxiliary generator will then supply power to the fuel pump motor.

The fuel pump motor will stop when FPC is de-energized. De-energizing FPC also causes pickup of the governor D solenoid resulting in immediate withdrawal of injector racks and engine shutdown.

ENGINE STARTING CIRCUIT

The D32U generator is used as a motor to crank the engine during engine start. This eliminates the necessity for separate starting motors.

The D32 generator is equipped with a shunt field, a separately excited field (battery field), and a starting field. During engine start the starting field is used and the battery field is disconnected. However, during power operation the battery field is used and the starting field is disconnected.

MP15 LOCOMOTIVE EQUIPPED FOR MULTIPLE UNIT OPERATION

When the locomotive controls are properly set up for engine starting, the isolation switch (IS) is in START position and the fuel pump relay FPR is energized. When the Fuel Prime/Engine Start FP/ES switch is held in the FUEL PRIME position, Fig. 1-8, battery power is applied to the fuel pump motor through FP/ES contacts 11-12 and 1-2. The fuel pump provides fuel to the engine injectors and is returned to the fuel tank by way of the return fuel sight glass on the engine mounted fuel filter.

After the system is primed, hold the FP/ES switch to ENGINE START. This energizes the generator (engine) start contactor GS, Fig. 1-10, and the fuel pump contactor FPC, Fig. 1-8. Pickup of GS provides cranking power to the main generator. Pickup of FPC sets up the fuel pump circuit so that the fuel pump is connected to the auxiliary generator when FP/ES is released. Pickup of FPC also provides a holding circuit to FPC. FPC remains energized until the feed is interrupted by opening the EFCO/STOP, EFCO1, or EFCO2 switch. Opening the feed to FCP provides a feed to the governor DV solenoid which results in immediate engine shutdown by withdrawing the injector racks. Opening the Control and Fuel Pump switch removes power from the fuel pump motor, but the engine will continue to run until the fuel in the system is used.

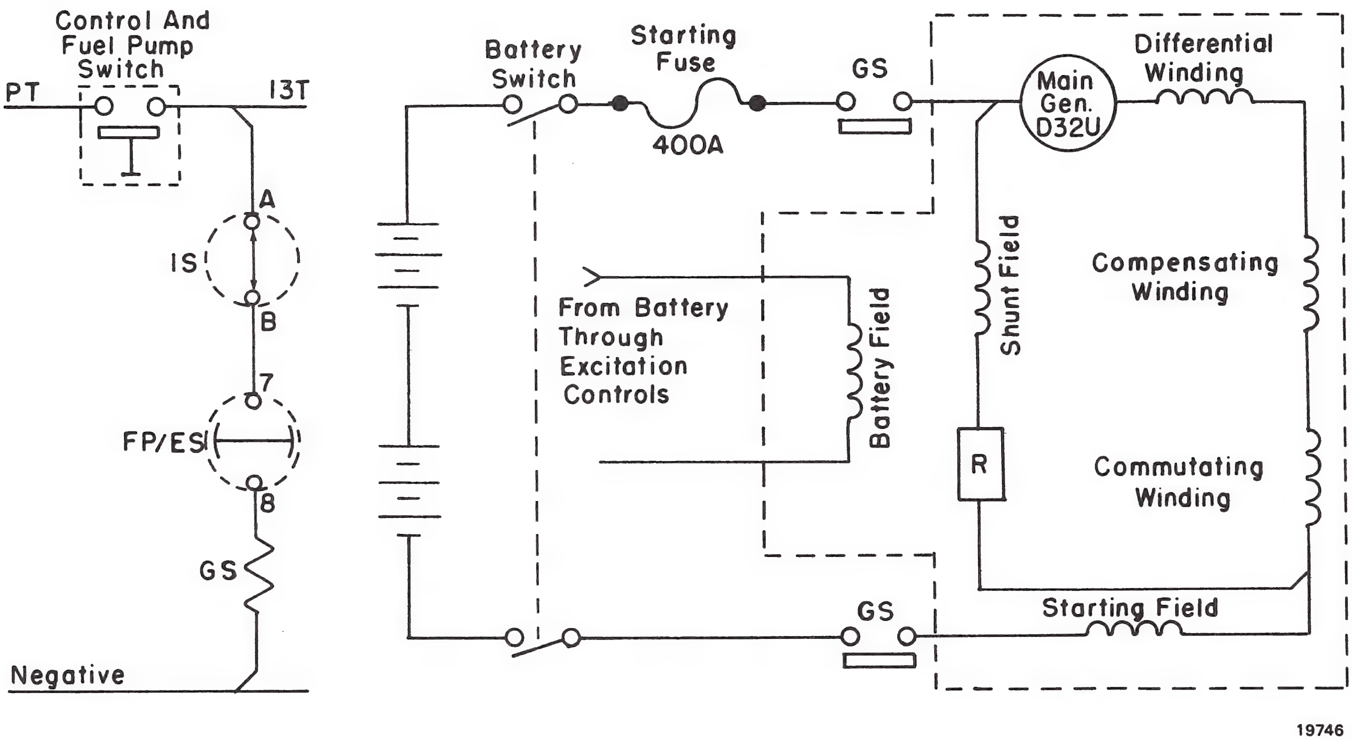

Fig.1-10 – Starting Circuit Of MP15DC Locomotive Equipped For Multiple Unit Operation, Simplified Schematic Diagram

After the engine has started, and FP/ES is released, GS drops out to remove cranking power from the main generator. Power is provided from the auxiliary generator to the fuel pump motor through FPR, FPC, and FP/ES contacts 5-6.

BASIC MP15 LOCOMOTIVE

When the locomotive controls are properly set up for engine starting, the reverser is centered. When the Fuel Prime/Engine Start FP/ES switch is held in the FUEL PRIME position, Fig. 1-9, battery power is applied to the fuel pump motor through FP/ES contacts 11-12 and 1-2. The fuel pump provides fuel to the engine injectors and is returned to the fuel tank by way of the return fuel sight glass on the engine mounted fuel filter.

After the system is primed, hold the FP/ES switch to ENGINE START. This energizes the generator (engine) start contactor GS, Fig. 1-11, and the fuel pump contactor FPC, Fig. 1-9. Pickup of GS provides cranking power to the main generator Pickup of FPC sets up the fuel pump circuit so that the fuel pump is connected to the auxiliary generator when FP/ES is released. Pickup of FPC also provides a holding circuit to FPC. FPC remains energized until the feed is interrupted by opening the Control and Fuel Pump switch, the EFCO/STOP switch, or one of the EFCO switches.

Opening the feed to FPC provides a feed to the governor DV solenoid which results in immediate engine shutdown by withdrawing the injector racks.

After the engine has started, and FP/ES is released, GS drops out to remove cranking power from the main generator. Power is provided from the auxiliary generator to the fuel pump motor through FPC and FP/ES contacts 5-6.

ENGINE STARTING PROCEDURE

CAUTION

Before attempting to start a new engine, an engine that has been overhauled, or an engine that has been shut down for more than 48 hours, perform PRELUBRICATION OF ENGINE procedure contained in Section 2.

If engine temperature is below 0° C (30° F) the engine should be preheated prior to starting.

1. Check oil level of engine, governor, and air compressor, and add oil if required. Check engine oil level in strainer housing and, if required, add oil to strainer housing until it overflows into the oil pan. Make certain that the strainer element is securely seated.

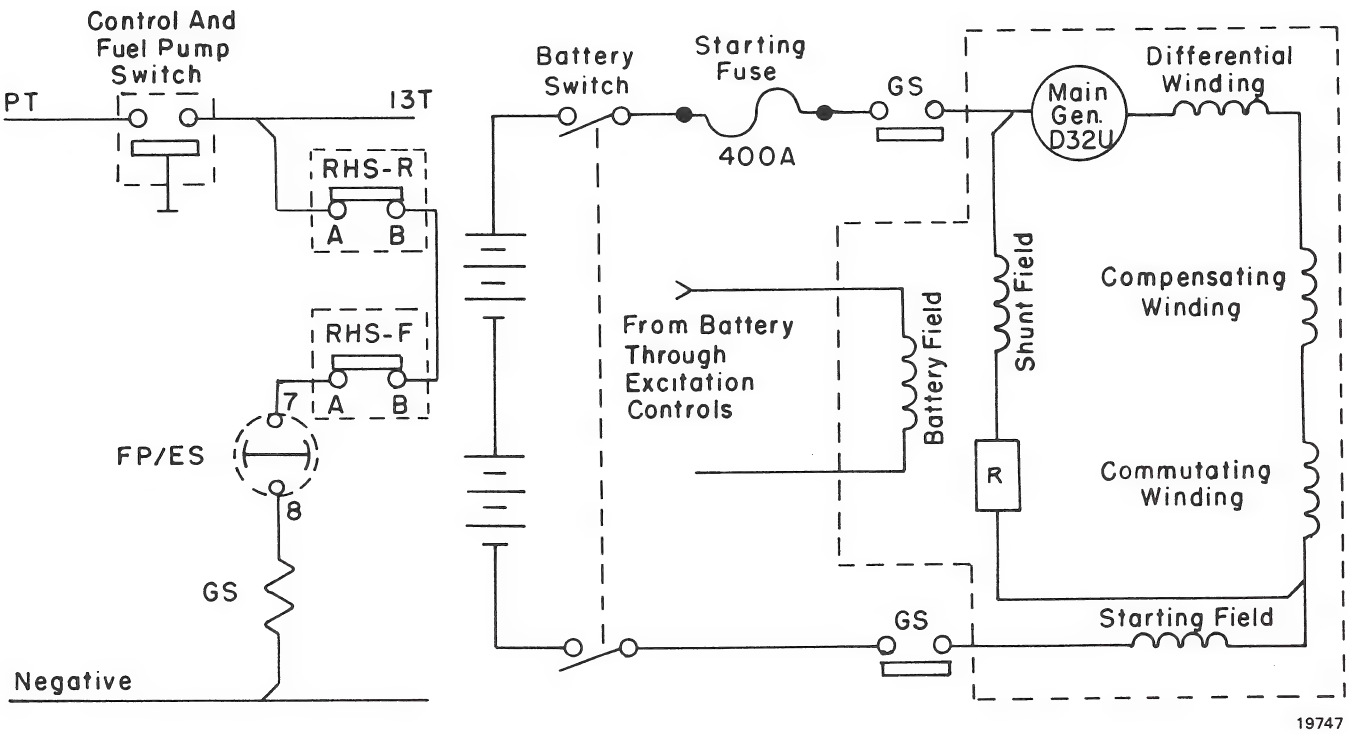

Fig.1-11 – Starting Circuit Of Basic MP15DC Locomotive, Simplified Schematic Diagram

2. Check engine coolant level.

3. Open cylinder test valves and bar over the engine at least one revolution. Observe for leakage from test valves. Close the test valves.

NOTE

It is good practice and highly recommended that the engine be *barred* over one complete revolution with the cylinder test valves open before starting. If any fluid discharge is observed from any cylinder, find the cause and make the necessary repairs. This practice should apply particularly to engines that are approaching a scheduled overhaul after several years of service or have had a history of water or fuel leaks.

4. Remove the starting fuse. Check that all fuses are installed, are in good condition, and are of the proper rating.

5. Verify that the main battery switch is closed, and that the ground relay switch is closed.

6. Place the local control and the control circuit breakers in the ON (up) position.

7. Place the control and fuel pump switch in the ON (up) position.

8. Place generator field and engine run switches in the OFF (down) position.

9. Place the isolation switch in the START position.

10. At the equipment rack in the engineroom, place the Fuel Prime/Engine Start switch in the PRIME position until fuel flows in the return fuel sight glass clear and free of bubbles.

11. Check that the starting fuse is in good condition and of the proper rating. Install starting fuse, Fig. 1-12.

CAUTION

Do not crank engine for more than 20 seconds or "inch" engine with starter. After cranking, allow a minimum of two minutes for starter cooling before another starting attempt.

If engine is equipped with purge control system, do not push injector rack control lever (layshaft) until engine has cranked for six seconds.

12. Position the injector control lever (layshaft lever) at about one-third rack (approximately 1.6 on the scale), then move the Fuel Prime/ Engine Start switch to the START position. Hold the switch in the START position until the engine fires and speed increases.

13. Release the injector control lever when the engine comes up to idle speed.

14. Check that the low water detector is not tripped. If the detector is tripped, wait for one-half minute after engine start, then press the reset button and hold for five seconds to reset. If the detector trips again, verify engine oil pressure, then slowly position the injector control lever to increase engine speed momentarily before resetting the button.

15. Check that cooling water level is satisfactory, that lube oil pressure is satisfactory, and that governor oil level is satisfactory.

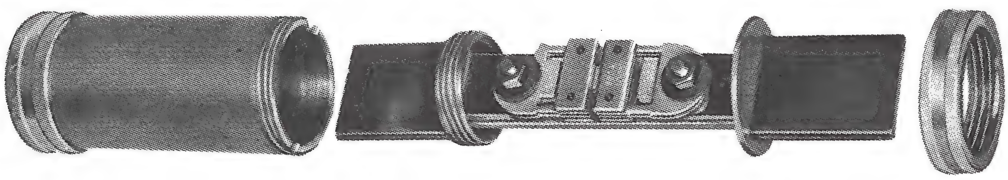

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Fig. 1-12 - Starting Fuse - 400 Amperes

SERVICE DATA

FUEL SYSTEM AND ENGINE STARTING

REFERENCES

Diesel Fuel Recommendations – All EMD And Former CDED Diesel Engines	M.I. 1750
Fuel And Soak Back Pumps	M.I. 4110
Fractional Horsepower Motors	M.I. 4101
Starting Motor Maintenance	Engine Maintenance Manual

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

FILTERS

	Part No.
Primary Fuel Filter	9502100
Pleated Paper Element	8345482
Cover Gasket	8358905
Engine Mounted Filter Assembly, Spin On Type	8479355
Filter Element	8423132
Suction Strainer	8341983
Wire Mesh Element	8344103
"O" Ring, Housing-To-Cover	8343161
Pressure Differential Gauge With Bypass Valve	9323489

FUEL PUMP

Fuel Pump Flange Gasket	8426937

SPECIFICATIONS

Fuel Tank Capacity

Basic	4 164 Litres (1100 Gal.)
Special Available	5 300 Litres (1400 Gal.)

LUBRICATING OIL SYSTEM

DESCRIPTION

A schematic diagram of the lubricating oil system is shown in Fig. 2-1. Oil is drawn from the engine oil pan sump and into the scavenging oil strainer compartment of the engine oil strainer. The scavenging oil pump draws oil through the strainer and forces it under pressure to the lubricating oil filter housing. Oil passes through the filter elements and is piped to the lube oil cooler. If the filters are clogged, a pressure release valve opens to bypass the clogged filters.

In the oil cooler the oil flows around tubes through which cooling water from the radiator is circulated. The cooled oil is then forced to the main and piston cooling oil strainer compartment of the engine oil strainer housing. Oil flows through the two strainers and into the upper deck of the compartment. Since the volume of oil pumped by the scavenging oil pump is greater than that drawn by the main and piston cooling oil pumps, the excess oil overflows back to the engine oil sump.

Oil is drawn by the main and piston cooling oil pumps from the upper deck of the strainer compart-

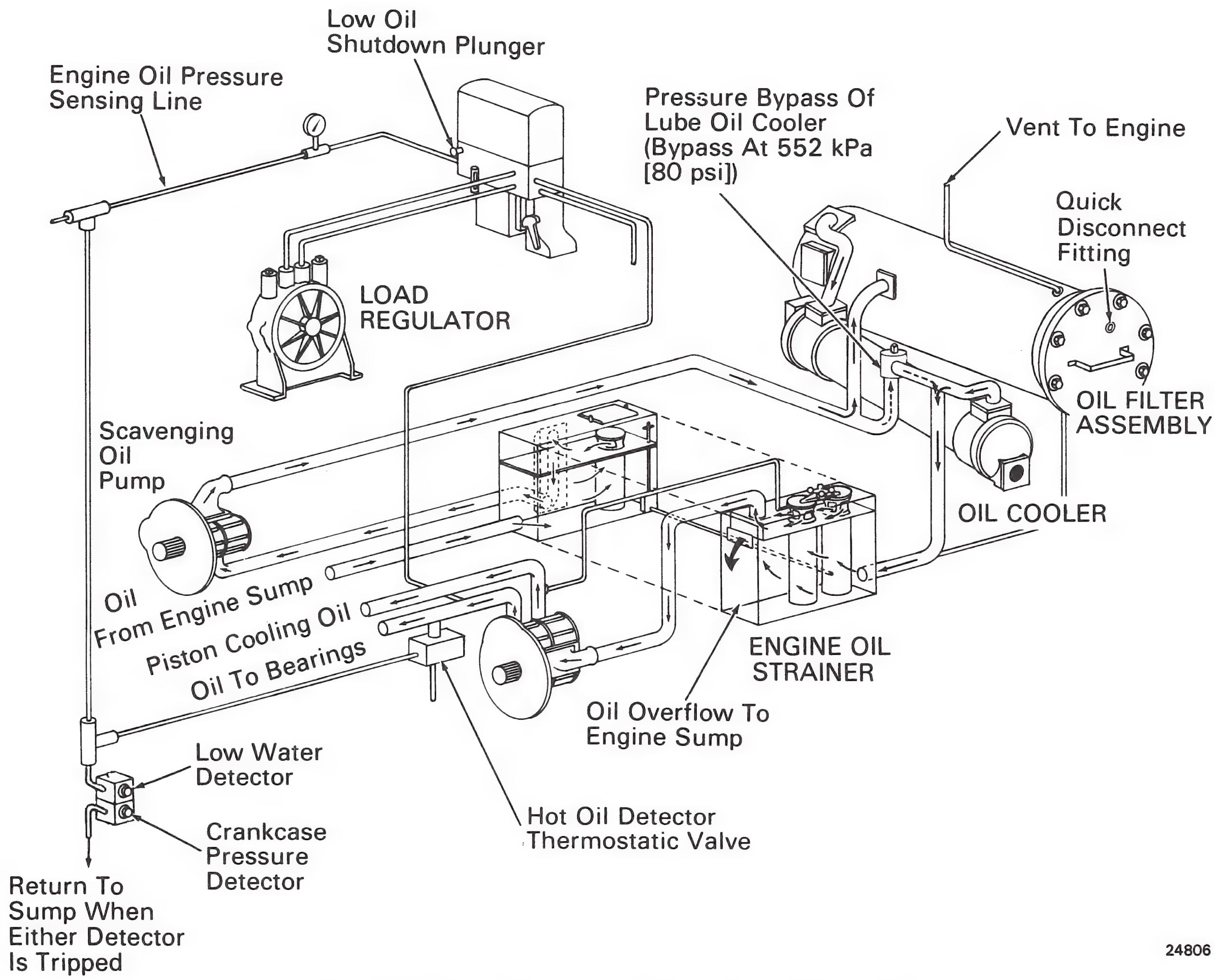

Fig.2-1 – Lube Oil System Simplified Diagram

ment. This oil is pumped to the engine to lubricate bearings and to cool the underside of the pistons. Oil is also pumped to the load regulator pilot valve in the engine governor and is directed by the valve to operate the load regulator vane motor clockwise and counterclockwise through a maximum arc of about 300°. Oil from the load regulator vane motor returns through the governor pilot valve to the engine oil sump. Note that governor oil is separate from the engine oil that passes through the load regulator pilot valve located in the governor.

Another engine oil connection is made to the governor. It connects to that portion of the engine where lowest oil pressure exists (the blower end). It provides a pressure indication to a sensor in the governor. When engine oil pressure is too low, a shutdown device trips to stop the diesel engine.

Engine protective devices, such as the low water/crankcase pressure detector and hot oil detector are connected to the oil pressure line from the engine. These devices dump oil from the line, bringing about engine shutdown.

ENGINE OIL LEVEL

The engine oil level should be checked with the engine hot and running at normal idle speed. A dipstick, Fig. 2-2, is located at the right side of the engine. With the engine running, it should show a level between the LOW and FULL marks.

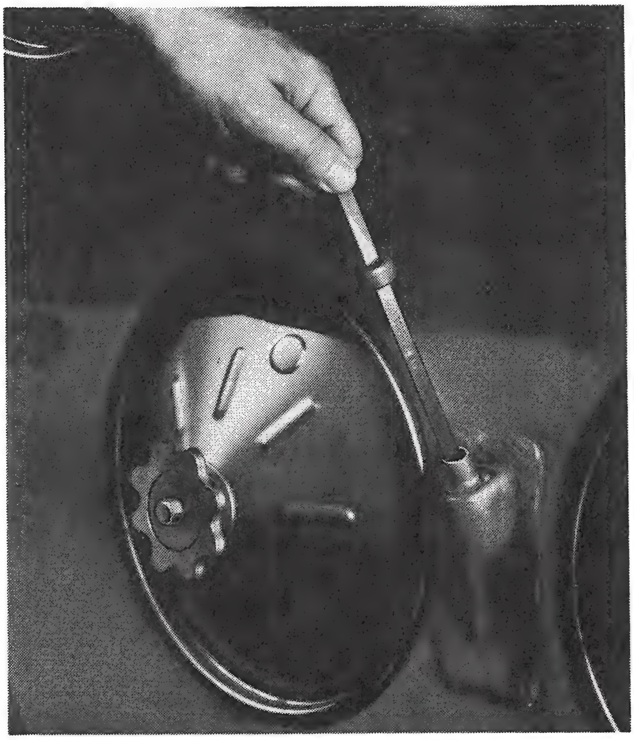

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Fig.2-2 – Checking Oil Level

When the engine is stopped, oil from the filter, cooler, and associated piping will drain back into the engine oil sump. If the oil level is checked with the engine stopped, the reading on the dipstick will be above the FULL mark if the system contains the normal amount of oil.

FILLING OR ADDING OIL TO THE SYSTEM

When filling or adding oil to the system, it is recommended that the oil be poured into the strainer housing through the square opening shown in Fig. 2-3. Should it be found more desirable to add oil through a handhole opening in the engine oil pan it is imperative that the strainer housing be filled before starting the engine. Failure to do this may result in serious engine damage due to the time delay before oil is completely circulated through the system and to the working parts of the engine.

If the system has not been drained, oil may be added to the strainer housing with the engine running or stopped.

WARNING

Do not remove the round caps from the strainer housing while the engine is running as hot oil under pressure will come from the openings and serious injury could result.

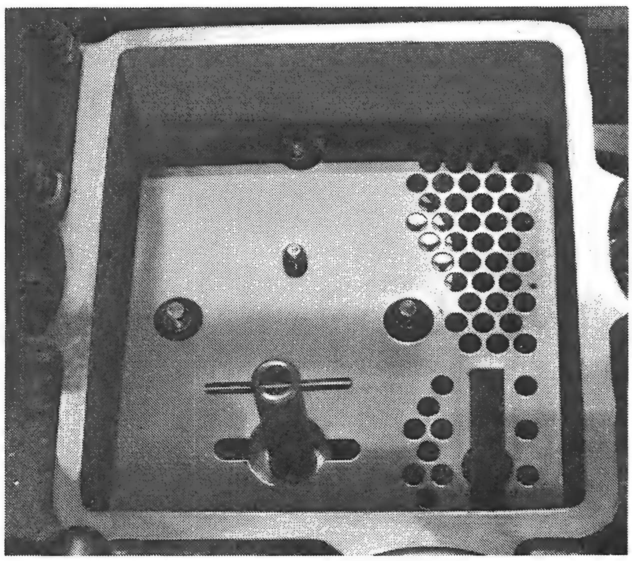

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Fig.2-3 – Strainer Housing

PRELUBRICATION OF ENGINES

Prelubrication of a new engine, an engine that has been overhauled, or an engine which has been inoperative for more than 48 hours, is a necessary and important practice. Prelubrication alleviates loading of unlubricated engine parts during the interval when the lube oil pump is filling the passages with oil. It also offers protection by giving visual evidence that oil distribution in the engine is satisfactory.

Perform prelubrication as follows:

1. Remove the pipe plug at the main lube oil pump discharge elbow, and connect an external source of clean, warm oil at the discharge elbow. Prelube engine at a minimum of 69 kPa (10 psi) for a period of not less than three and not more than five minutes (approximately 57 litres/min. [15 gpm] using a 1.1 to 1.5 kW [1-1/2 to 2 hp] motor).

2. While oil pressure is being applied, open the cylinder test valves and bar the engine over one complete revolution. Check all bearings at the crankshaft, camshafts, rocker arms, and at the rear gear train for oil flow. Also check for restrictions and excessive oil flow. Check for fluid discharge at the cylinder test valves.

3. On new or overhauled engines remove the pipe plug at the piston cooling oil pump discharge elbow and connect the external oil source at that opening. Check for unrestricted oil flow at each piston cooling tube.

4. Disconnect the external oil source and replace the pipe plugs at the pump discharge elbows. Close the cylinder test valves.

5. Pour a liberal quantity of oil over the cylinder mechanism of each bank.

6. Check oil level in strainer housing and, if required, add oil to strainer housing until it overflows into the oil pan.

7. Replace and securely close all hand hole covers and engine top deck covers.

NOTE

When an engine is replaced due to mechanical breakdown, it is important that the entire oil system, such as oil coolers, filters, and strainers, be thoroughly cleaned before a replacement engine or the reconditioned engine is put in service. A recurrence of trouble may be experienced in the clean engine, if other system components have been neglected.

In some cases engines have been removed from service and stored in the "as is" condition by draining the oil and applying anti-rust compound. When these engines are returned to service, before adding oil and prelubing, care must be taken to see that any loose deposits are flushed out before adding a new change of oil. The entire engine should be sprayed with fuel, to break up any sludge deposits, and then drained, being careful that the drains do not plug. Fuel should not be sprayed directly on the valve mechanism or bearings, as lubrication will be removed or dirt might be forced into these areas. The surfaces should then be wiped dry before the new oil is added to the engine.

LUBRICATING OIL SAMPLING AND ANALYSIS

A lubricating oil sample should be taken for analysis at the intervals stipulated in the Scheduled Maintenance Program. The sample should be submitted to a competent laboratory to monitor the suitability of the oil for continued use. Obtain the sample in the following manner:

1. Run the engine long enough to ensure thorough circulation.

2. Shut the engine down and remove the starting fuse.

3. Obtain the oil sample 0.5 litre (normally 1 pint) at the center of the engine oil pan half-way between the surface and the bottom of the pan.

NOTE

In consistent sampling techniques will produce inconsistent results.

OIL COOLER INSPECTION AND MAINTENANCE

Major servicing of the oil cooler should not be undertaken until the need for such maintenance is definitely etablished by unsatisfactory operation, suspected oil cooler core leaks, or wide temperature differential between cooling water and engine lube oil.

DETECTION OF LEAKS

There are no simple methods of detecting water leaks to the oil side of the lubricating oil cooler

assembly; however, evidence of water contamination will show up in the routine engine oil samples taken and analyzed as prescribed in the Scheduled Maintenance Program. Any such evidence calls for a close examination of the cooler and inspection of the engine. Maintenance Instructions for cleaning and repair of the lubricating oil cooler are listed on the Service Data page.

DETECTION OF DIRTY OIL COOLER CORE

Proper lubricating oil temperatures are dependent upon maximum lube oil cooler performance. Operation of the hot lubricating oil detector provides indication that the lube oil cooler may not be functioning efficiently. However, in order to obtain a valid indication of oil cooler performance, the locomotive must be operated at its full rated load and engine speed while the oil and water temperatures are allowed to stabilize.

PROCEDURE

1. At the water pump discharge elbow, Fig. 2-4, fill the thermometer well with oil. Water temperature into the engine will be taken at this point.

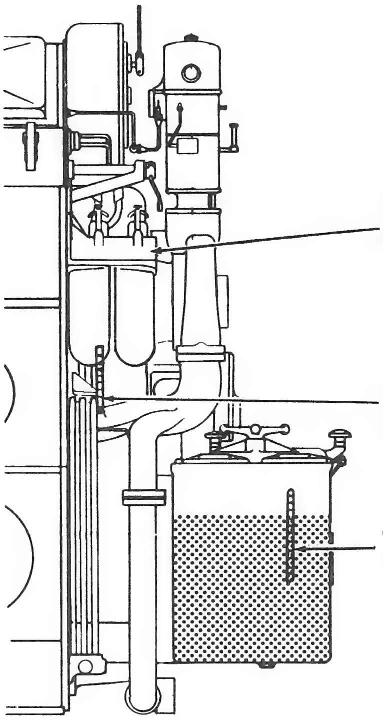


Fig.2-4 - Location Of Thermometers To Determine Oil And Water Temperature Differential

2. Set up engine loading apparatus capable of taking the full rated load of the locomotive.
3. Remove the square cover from the engine mounted oil strainer and hang a caged thermometer in the overflow oil compartment of the strainer housing, Fig. 2-4. This is oil out of the cooler. Make certain that the thermometer bulb is well below the surface of the oil and is kept well submerged when the reading is taken.
4. Insert a thermometer into the well located at the engine water inlet.
5. Operate the engine and apply load. Do not operate above throttle position No. 3 until water temperature is above 54.5° C (130° F). Operate at full load and full engine speed until engine water inlet temperature is stabilized. It may be necessary to block the shutters to maintain a constant water temperature in the range of 71°-79.5° C (160° to 175° F).

NOTE

Equal readings taken at 15 minute intervals will indicate a stable operating condition.

6. Record the temperature readings and compare them with the performance baseline given on the Service Data page. When oil temperature for a given water temperature reading is higher than the limit indicated by the line, the oil cooler should be serviced in accordance with the Maintenance Instruction listed on the Service Data page.

OIL FILTER INSPECTION AND MAINTENANCE

Oil filter element replacement should be made as determined by scheduled pressure monitoring of the oil filter tank unless the replacement interval specified in the Scheduled Maintenance Program or a laboratory analysis of lube oil dictates earlier replacement.

QUICK DISCONNECT FITTING

The lube oil filter tank cover is equipped with a male quick disconnect fitting, Fig. 2-5, to accept a female coupler. The fitting facilitates application of a pressure gauge to monitor filter tank pressure, which indicates the condition of the filter elements.

Periodic pressure readings will help prevent undue engine wear by alerting the maintenance crew when

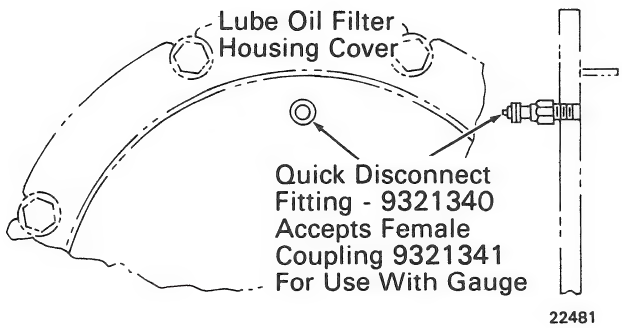


Fig.2-5 – Lube Oil Filter Bypass Indicator And Quick Disconnect Fitting Application

filter element plugging and bypass are about to occur. If a locomotive has a short filter element life, there may be water leaks or a heavy dirt load. The engine probably needs maintenance.

Lube oil filter pressure checks are to be made *weekly or oftener*; the engine may be loaded or unloaded. However, the best time to perform these tests is soon after a unit comes in from a run, thereby ensuring an adequately high degree of lube oil temperature. (Readings must be taken when lube oil temperature is at least 66° C [150° F]). Since there is no convenient gauge to indicate lube oil temperature, perform test when *water* temperature is a minimum of 66° C (150° F).

Filter elements should be renewed if filter tank pressure reaches:

345 kPa (50 psi) at throttle position No. 8;

104 kPa (15 psi) at idle engine speed.

Readings taken at throttle No. 8 engine speed are the most reliable. Therefore, if a marginal reading is obtained at idle engine speed, verify filter element condition at No. 8 engine speed.

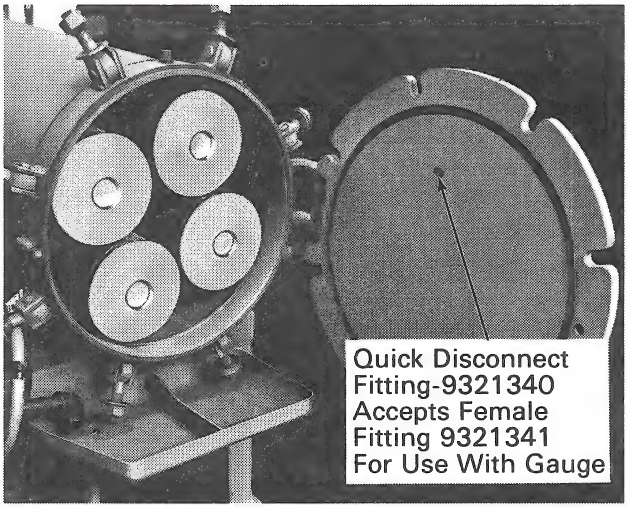
ELEMENT CHANGE PROCEDURE

1. Operate the diesel engine until oil is warm and circulating freely, then stop the engine and remove the starting fuse.

NOTE

Depending upon the temperature of the oil and system, adequate drainage of the lube oil filters can take from 1/2 hour for hot oil and a hot system to several hours for a cool system.

2. After enough time has elapsed to allow adequate drainage and easy handling of the filters slightly loosen the nuts on the filter housing cover, Fig. 2-6. Oil remaining at the bottom of the housing will leak into the drain pan. From there it is piped to the engineroom drainage sump.
3. Provide adequate quantities of bound edge shop towels.
4. Place a container for used filter elements at a convenient location.
5. After oil has stopped draining from under the flat filter housing cover, loosen the retaining nuts and swing the hinge bolts clear of the cover. Swing the cover open. Remove and quickly dispose of used filter elements.
6. Using bound edge shop towels, clean out the interior of the filter housing. Clean up the drain pan and surrounding area.
7. Insert a set of four new filter elements consisting of part number shown on the Service Data page. Make certain that the elements are fully seated over the standpipes.
8. When the filter elements are properly inserted, place a new gasket into the circular groove in the housing cover. Discard the used gasket.
9. Close the cover. A guide hole in the filter cover must mate with a dowel on the filter housing body before the cover can be closed.
10. Swing the hinge bolts into place and tighten the hold-down nuts.
11. At the intervals stipulated in the Scheduled Maintenance Program, remove and inspect the bypass valve assembly, Fig. 2-7. The procedure is detailed in "Inspection Of Bypass Valve Assembly."
12. Before starting the engine, check the oil level, using the dipstick. Oil level should be above the full mark on the dipstick with the engine shut down. Start the engine and allow it to run at idle speed. Check the oil level at the dipstick. Add oil if necessary.
13. Inspect for oil leaks at the filter housing. Tighten the hold-down nuts as necessary to stop any leaks.



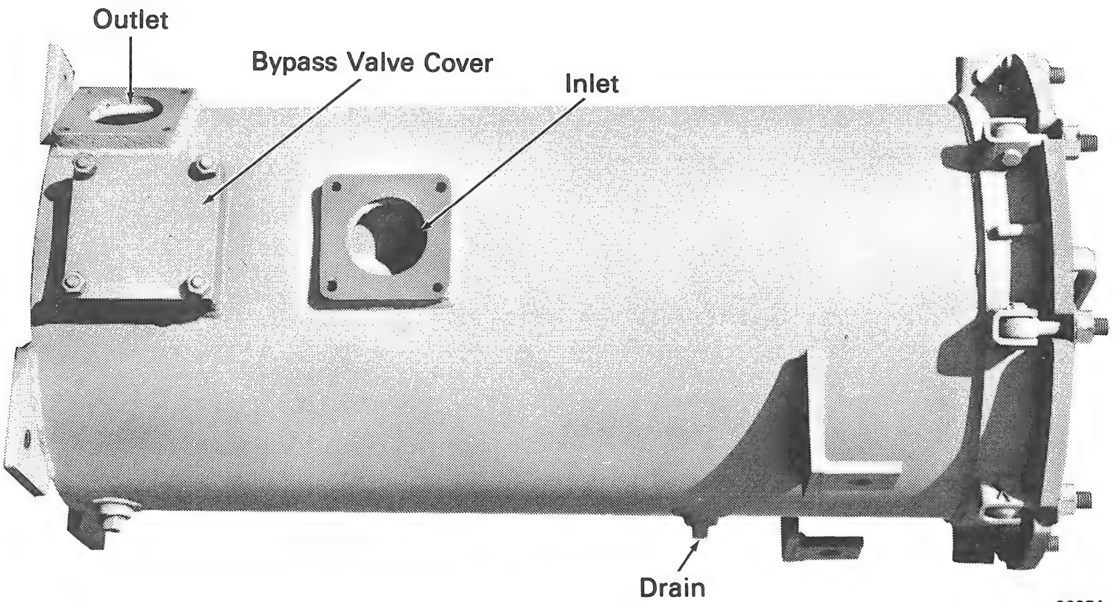


Fig.2-6 – Four Element Lubricating Oil Filter Assembly

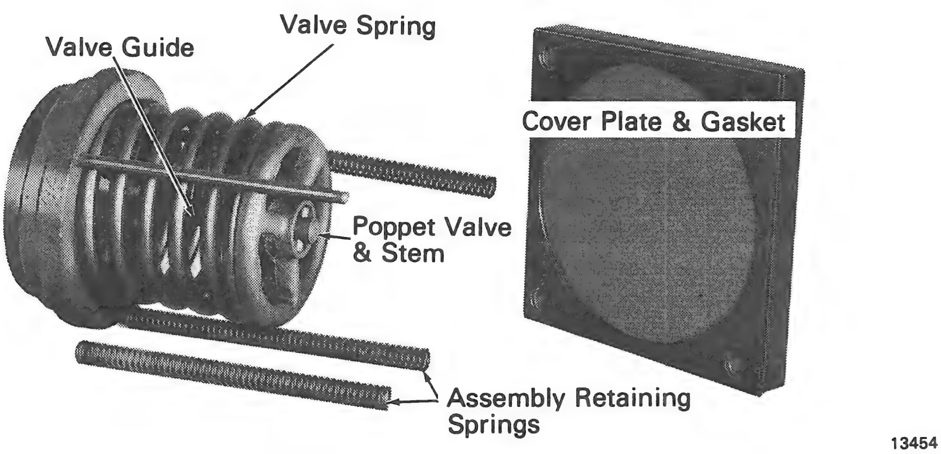


Fig.2-7 – Filter Bypass Valve Assembly

INSPECTION OF FILTER BYPASS VALVE ASSEMBLY

The bypass valve assembly, Fig. 2-7, should be removed and checked periodically at intervals stipulated in the Scheduled Maintenance Program or whenever improper oil filtration is suspected. However, operation of the valve assembly cannot be effectively checked on the locomotive. For this reason it is recommended that qualified spare assemblies be available for exchange with the assembly in use. A bench test and inspection may then be performed in accordance with the appropriate Maintenance Instruction listed on the Service Data page.

PROCEDURE

1. After the oil has been drained from the filter housing, the filters removed, and the housing cleaned; remove the four hold-down nuts from the bypass valve port cover. Remove the valve assembly and discard the port cover gasket.

NOTE

Three light springs hold the valve assembly seated in position and against the valve port cover. Bypass valve spring pressure is not felt during removal of the assembly.

2. Replace the bypass valve assembly with a qualified spare. Seat the assembly properly with the three light guide springs in place. Apply a new port cover gasket and the port cover. Tighten the cover hold-down nuts to between 75 to 81 N·m (55 and 60 ft-lbs) torque, using standard tightening procedure.

   If a qualified spare is not available the valve assembly should nevertheless be removed from the filter housing and cleaned free of sludge and varnish by washing in solvent. The assembly should be carefully inspected after cleaning. If the poppet stem or valve body guide is worn, those pieces should be replaced with new pieces. Part numbers are listed on the Service Data page.

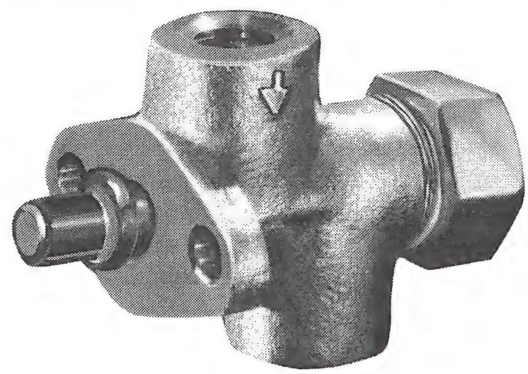
TEST OF VALVE SPRING

If a qualified spare is not available, the valve spring should be tested by compressing it to a specific height. If this requires more or less than the values shown on the Service Data page, the spring should be replaced with a new spring.

HOT LUBRICATING OIL DETECTOR

A thermostatic valve, Fig. 2-8, located on the outlet elbow from the main lube oil pump is calibrated to open when lube oil temperature reaches nominally 127° (260° F). At this temperature the probability exists that either the lube oil cooler is plugged on the water side or steam pressure in the cooling system is preventing engine shutdown by the low water detector.

Start To Open Temperature	Full Open Temperature
122° to 125° C (252° to 257° F)	135° C (275° F)



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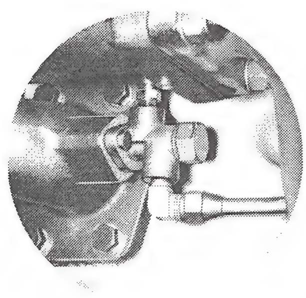

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Fig.2-8 – Hot Oil Detector Thermostatic Valve

When oil temperature causes the valve to open, pressure to the oil pressure sensing device in the engine governor is dumped. The device sees low oil pressure and reacts to shut the engine down.

The thermostatic valve is not latching, and it will reset automatically when oil temperature falls. The engine may then be restarted when the governor low oil plunger is reset.

WARNING

After it has been determined that hot oil is the cause for engine shutdown, make no further engineroom inspections until the engine has cooled sufficiently to preclude the possibility that hot oil vapor may ignite. When a low oil shutdown occurs, always inspect for an adequate supply of water and oil before attempting to restart the engine. Also check engine water temperature. Do not add cold water to an overheated engine.

CENTER BEARING LUBRICATION

Two litres (two quarts) of all purpose lubricating oil, per M.I. 1756, should be added to the truck center bearing at the interval indicated in the Scheduled Maintenance Program.

LUBRICATION AT TIME OF TRUCKING

Remove oiler pipe plugs, Fig. 2-9, before trucking or untrucking the locomotive. Apply oil as follows:

If the bearing is dry, add 1.7 litres (3-1/2 pints) of oil before trucking, and add another 1.7 litres (3-1/2 pints) after the unit is trucked.

Reapply oiler pipe plugs after unit is trucked and oiled.

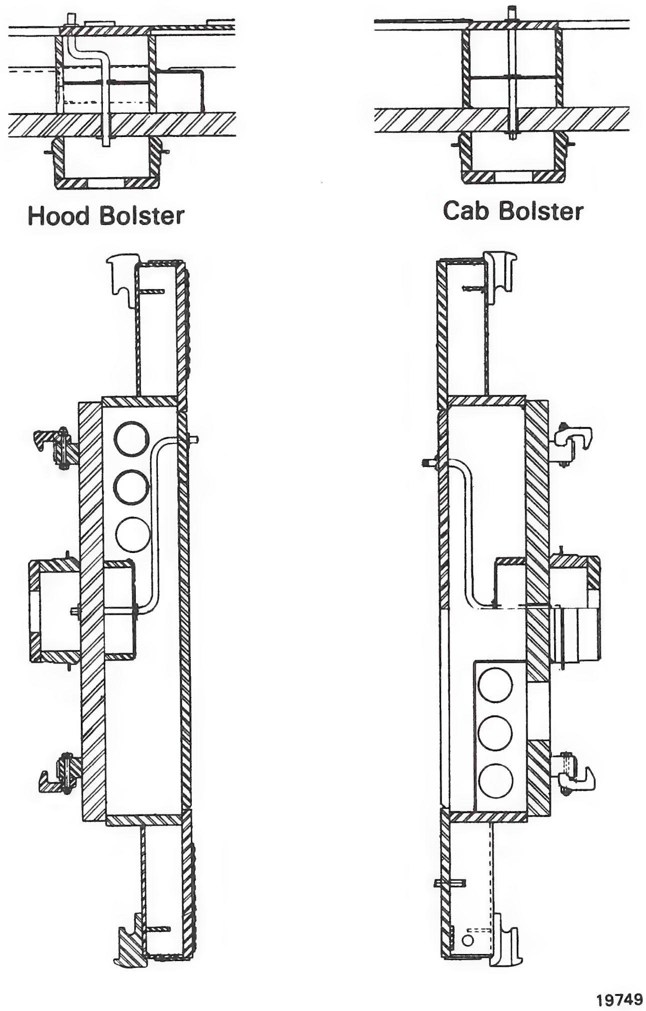

Fig.2-9 - Center Bearing Oiler Pipe Location

SERVICE DATA

LUBRICATING OIL SYSTEM

REFERENCES

Lubricating Oil Filtration	M.I. 926
Luricating Oil Coolers	M.I. 927
Lubricating Oil For Domestic Locomotive Engines	M.I. 1752

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

FILTERS

	Part No.
Cotton Paper Elements (4 per housing)	8345482
Filter Housing Cover Gasket	8330035
Bypass Valve Port Cover Gasket	8396030
Bypass Valve Assembly	8320705

NOTE

It is recommended that qualified spare bypass valve assemblies be kept available for scheduled maintenance replacement.

Kit: Lube Oil Filter Pressure Test (690 kPa [0-100 psi] gauge, hose, and female quick disconnect)	9325061

SPECIFICATIONS

Weight required to compress filter bypass valve spring 8317190 to a height of 92 mm (3-5/8″) must be not less than 191 kg (420 lbs) or more than 227 kg (500 lbs). (This is the 276 kPa [40 psi] spring.)

Lubricating Oil System Capacity	625 Litres (165 U.S. Gals.)
Lube Oil Cooler Bypass Valve Opens	552 kPa (80 psi)

COOLING SYSTEM

DESCRIPTION

The cooling system is pressurized to provide uniform cooling throughout the operating range of the diesel engine. A schematic diagram of the system is shown in Fig. 3-1. Coolant is pumped by the engine mounted pump from the cooling water expansion tank and lubricating oil cooler assembly and into the engine. The heated water leaves the engine and flows through the radiator assembly where it is cooled. The cooled water returns to the oil cooler to repeat the cycle.

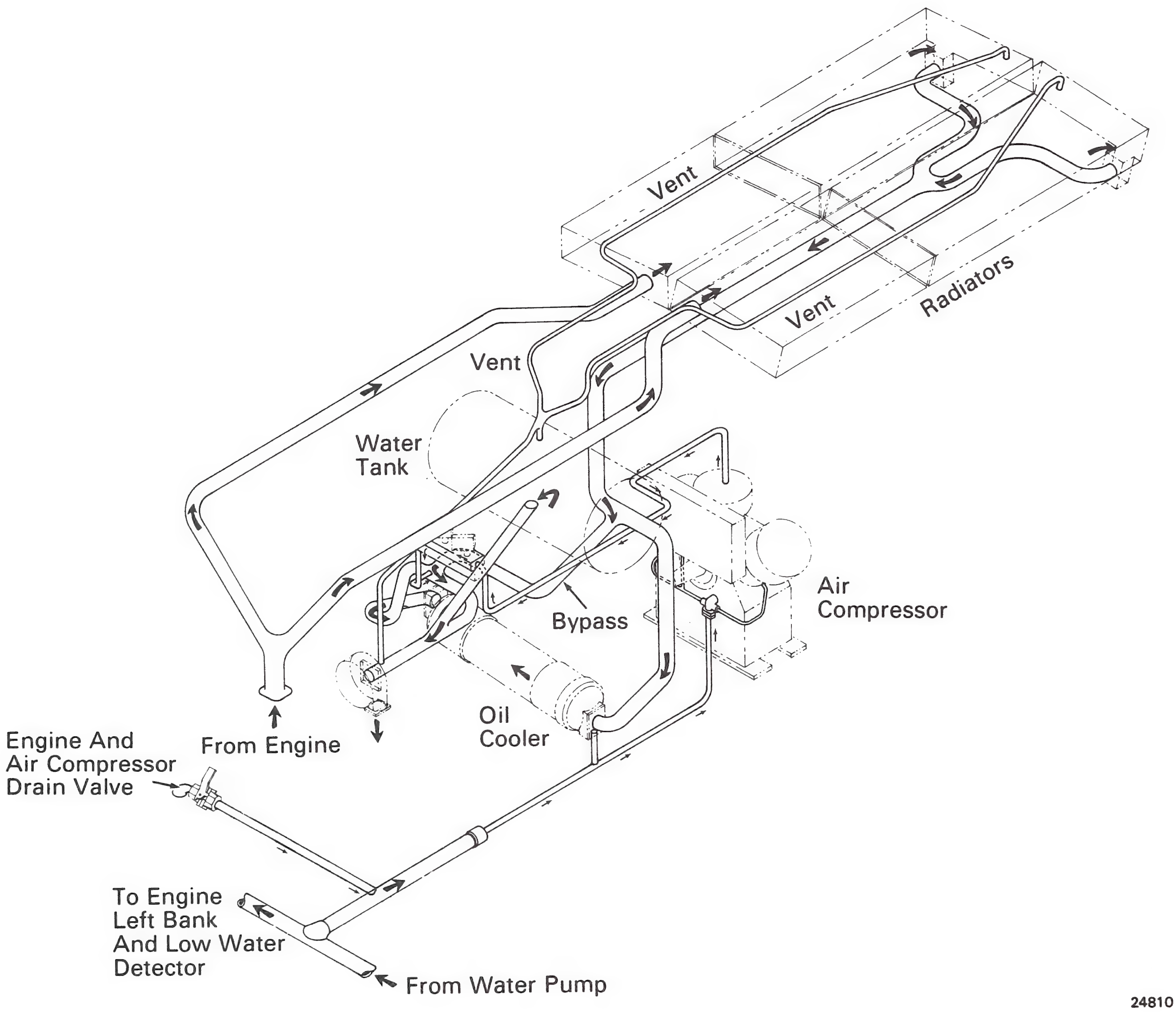

Fig.3-1 – Cooling System Schematic Piping And Pictorial Diagram

A bypass line located around the oil cooler reduces the velocity of water flow through the cooler in order to minimize erosion.

Part of the water from the engine mounted water pump is piped to the air compressor. There are no valves in the line, thus air compressor cooling will be provided whenever the engine is running. Upon leaving the air compressor, water is piped through a temperature switch manifold, then back to the oil cooler for recirculation. Temperature sensing elements located in the manifold operate switches that control radiator shutter operation and a hot engine alarm.

To drain the entire cooling system, open the engine and compressor drain valve. Allow the drain valve to remain open until the entire system is drained.

TEMPERATURE CONTROL

During circulation through the diesel engine and air compressor, the cooling system water picks up heat which must be dissipated. This heat is dissipated and the water temperature controlled by means of a radiator assembly and an engine driven cooling fan.

The radiators are assembled in a hatch in the top of the hood end of the locomotive. The hatch contains radiator sections which are grouped in two banks.

The radiator cooling fan is pedestal mounted at the front end of the hood. The fan is driven from the engine through the compressor and a set of matched V-belts between the compressor and the fan pedestal. The fan draws cooling air in through the front of the hood and directs it upward through the radiator assembly. The cooling fan operates anytime the engine is running. The two pedestal mounted fan drive bearings should be lubricated at intervals stipulated in the Scheduled Maintenance Program.

Shutters, located in front of the cooling fan, are operated by an air cylinder which is controlled by the shutter magnet valve MV-SH. Shutter control and thus water temperature is entirely automatic.

A shutter control temperature switch STS is located at the equipment rack and is flange mounted to a manifold located in the cooling system piping. Water discharge from the compressor passes through the manifold where it acts on a thermal element that causes the switch to establish a circuit to MV-SH. An additional switch, ETS, responds to overheating by sounding an alarm and lighting the HOT ENGINE indicator.

SHUTTER CONTROL

During normal operation with STS closed and MV-SH energized through the closed contacts of the engine temperature relay ETR, air under pressure is admitted to the shutter operating cylinder, where it drives the piston and the shutter operating bars to close the shutters.

When STS is opened, due to an increase in water temperature, MV-SH is de-energized, Figs. 3-2 and 3-3. Air is released from the shutter operating cylinder and discharges at the magnet valve vent allowing spring tension within the cylinder assembly to pull the shutters open. Air is then drawn through the shutters by the fan and is forced through the radiator, picking up heat from the circulating water. The air is then discharged through the roof of the locomotive.

However, if STS fails to operate, the engine temperature switch ETS will close as water temperature rises. This provides a feed to engine temperature relay ETR. Pickup of ETR drops the feed to MV-SH and the shutters open. Therefore, ETS acts as a back up for STS and also provides an alarm.

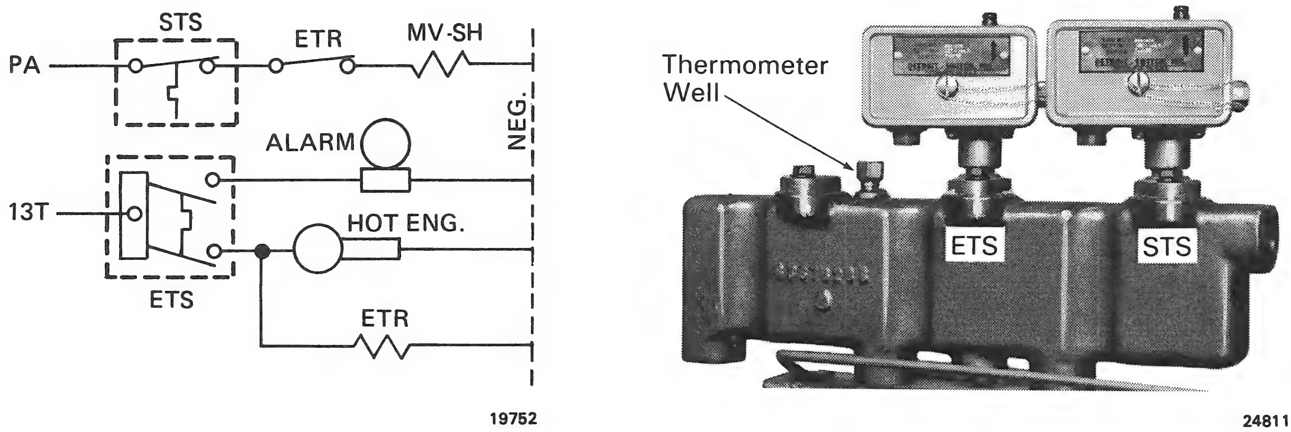

Fig.3-2 - Engine Temperature Switches And Circuit Diagram

MANUAL SHUTTER CONTROL VALVE

A valve, Fig. 3-3, is provided for control of the shutters. When the valve handle is in the OPERATING position, the valve allows air from the shutter control magnet valve to drive the shutter operating piston and close the shutters. When the shutter magnet valve MV-SH is de-energized, air from the shutter operating cylinders passes through the manual valve and discharges at the magnet valve vent.

When the handle of the valve is placed in the TEST position (90° clockwise from OPERATING), air from the magnet valve is blocked, the operating cylinders are vented to atmosphere and the shutters open.

NOTE

On a unit shipped dead in a train, the dead engine feature limits main reservoir pressure. This pressure, applied through the shutter magnet valve, is not sufficient to operate the shutter piston against the built-in spring pressure.

SHUTTER POSITION ADJUSTMENT

1. Place the manual shutter control valve in the TEST position (90° clockwise). This will release operating air and allow spring pressure to draw the shutters open.
2. Release the locknut at the adjustment threads of the piston ball joint extension rod. Adjust the rod to obtain shutter blade angle of 90° ± 2° (fully open). Tighten the locknut.
3. Slowly operate the manual shutter control valve handle to the OPERATING position to close the shutters.
4. Verify shutter operation by alternately positioning the manual shutter control valve handle in the OPERATING and TEST positions, then return the valve to the OPERATING position. The shutters will close.

HOT ENGINE ALARM

A hot engine alarm switch ETS is located in the temperature switch manifold where it senses the water temperature into the engine. The ETS will close when the water temperature at the inlet to the engine water pumps approaches the boiling point of water under normal system pressurization.

When the switch picks up, the alarm will ring in all units of a consist, and the hot engine light will come on in the unit affected. Pickup of ETS also results in reduced speed and power.

An accurate check of engine water temperature may be obtained by placing a thermometer in the thermometer well located on the temperature switch

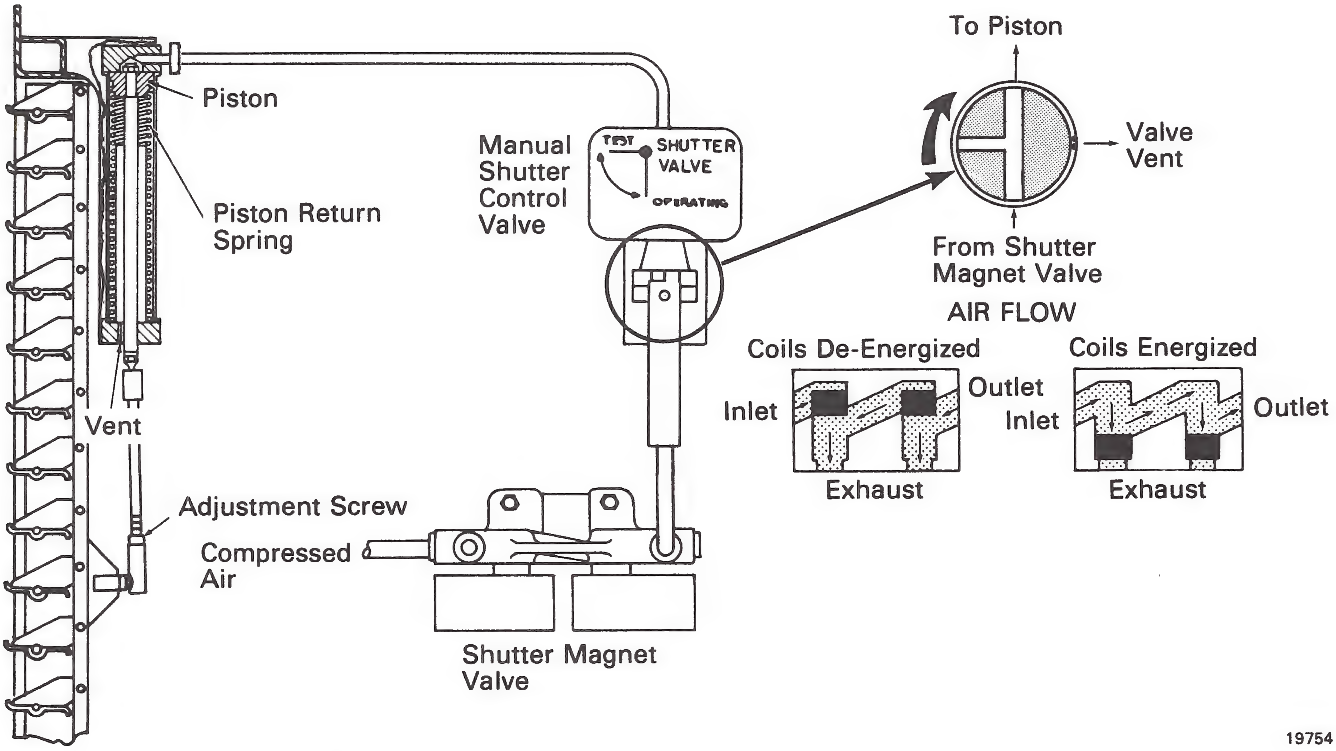

Fig.3-3 – Shutter Operating Piston Arrangement

manifold, Fig.3-2. The proper operating temperature for the engine temperature switch is given on the temperature switch nameplate and is on the Service Data page. The switch part number can be verified on the locomotive wiring running list.

As a backup to ETS action, a hot oil detector is located on the outlet elbow of the main lube oil pump. Should ETS fail to reduce engine temperature and a boiling condition create pressure that prevents low water detector trip, oil temperature will increase. A thermostatic valve will dump pressure oil in the line to the governor low oil pressure detector and bring about engine shutdown.

The thermostatic valve will reset automatically after the hot oil cools, but it is recommended that no attempt be made to start the engine after a hot oil shutdown until a thorough engine inspection is made by qualified personnel.

WARNING

After it has been determined that hot oil is the cause for engine shutdown, make no further engineroom inspections until the engine has cooled sufficiently to preclude the possibility that hot oil vapor may ignite.

COOLING SYSTEM PRESSURIZATION

The cooling system is pressurized to increase the boiling point of the coolant and prevent cavitation at the water pump during transient high temperature conditions, such as operation through long tunnels. A pressure cap, Fig. 3-4, on the water tank filler pipe opens at approximately 48 kPa (7 psi) to relieve excessive pressure and prevent damage to cooling system components. The cap is also equipped with a vacuum breaker valve that operates as the system cools. Refer to the Service Data page for pressure cap operating limits and identifying number.

The pressure cap is equipped with a handle that facilitates application and removal, but more importantly it interlocks with the fill/refief valve handle. This ensures that system pressure is released through the fill/relief pipe before the cap can be loosened.

WARNING

Always relieve system pressure before attempting to remove pressure cap or water tank plugs.

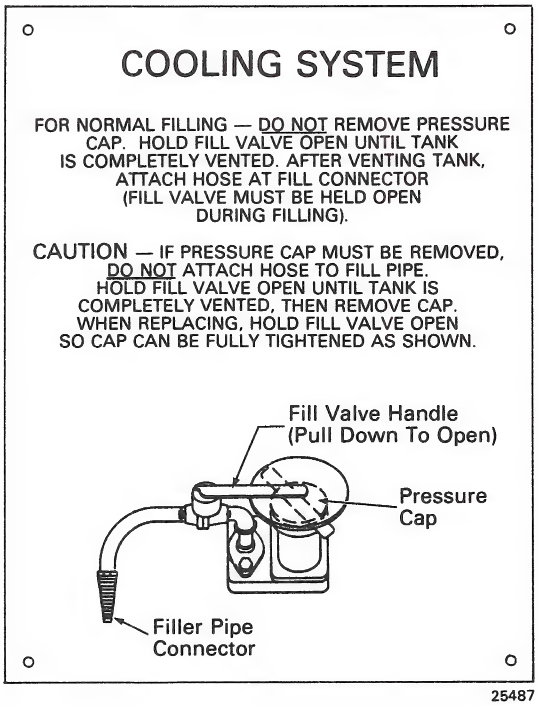

Fig.3-4 - Cooling System Pressure Cap And Fill/Relief Arrangement

LOW WATER SHUTDOWN

A low water detecting device, Fig. 3-5, balances water pump input and discharge differential pressure against air box pressure. When the differential pressure across the water pump becomes less than the air box pressure, the device dumps oil from the governor supply line, causing an engine shutdown. When a low water shutdown occurs, the low water reset button pops out, the low oil plunger on the governor protrudes, and the governor shutdown light on the engine control panel comes on.

Since the detector compares pump differential with air box pressure, it cannot be tested on a non-operating engine. The engine must be running, and the cooling system vented in order to latch the low water reset button.

Depress the low water reset button during engine start allowing enough time for the water pump to draw from the makeup tank and distribute to the radiators for proper circulation. Tripping at engine start is not an indication that the device is defective. Once water pump pressures have been established, it is merely necessary to reset the device within about 50 seconds after trip during starting. If the device is difficult to reset, confirm engine oil pressure, operate the injector rack manual control lever to speed up the engine, and then press the reset button.

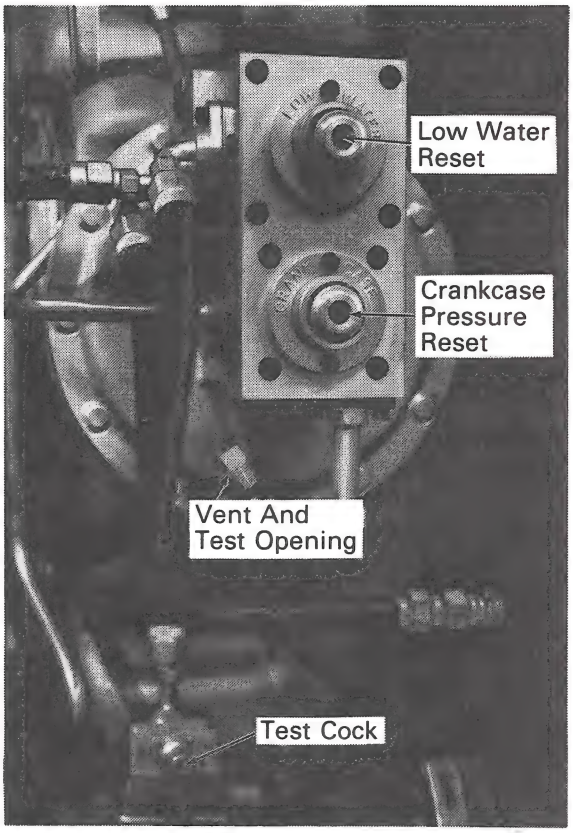

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Fig.3-5 – Differential Low Water And Crankcase (Oil Pan) Pressure Detector

TESTING FOR LOW WATER SHUTDOWN

Operation of the low water shutdown device, Fig.3-5, should be checked at intervals stated in Scheduled Maintenance Program or whenever faulty operation is suspected.

To test operation of the low water detecting device, run the engine at idle speed and turn the test cock mounted on the water pump discharge elbow to the horizontal position. The low water button should pop out smoothly without hesitation after water trapped behind the operating diaphragm escapes through the drain hole provided (in not more than a few seconds of time). Return the test cock to the vertical position.

Observe the low oil plunger on the governor as it moves out. The plunger should extend fully and the engine begin to shut down in about 55 seconds. As the engine begins to shut down reset the low water button and the low oil plunger. Operate the rack positioning lever to bring the engine back up to idle speed before complete shutdown. Verify that the low water button stays set.

If the low water shutdown reset pushbutton does not pop out freely without assistance when the test cock is opened and the engine is at idle, the device should be removed and replaced with an operative device. Refer to the Service Data page for a listing of instructions covering maintenance and qualification of the low water protector. Special apparatus is required for proper testing.

The crankcase pressure detector may be tested in a similar manner by applying a rubber tube over the vent and test opening of the detector and applying suction to trip the lower button.

CAUTION

Diaphragm can be damage by applying a positive pressure or excessive suction at the vent tube.

AUTOMATIC COOLING WATER DRAIN SYSTEM (SPECIAL EXTRA)

The automatic cooling water drain system provides protection against cooling system freeze-up if an engine has shut down and has not been manually drained. This system consists of two major components, a solenoid operated automatic drain valve, and the external electrical control circuitry.

A bi-metallic sensor mounted in the drain valve body is designed to activate the automatic drain when descending coolant temperature reaches 7° C (45° F). A cold water fill switch is provided to electrically override the automatic drain valve (close it), for refilling a drained engine or to facilitate cold water filling. The system circuitry is automatically reset when the engine is cranked.

OPERATING WATER LEVEL

An operating water level instruction plate, Fig. 3-6, is provided next to the water level sight glass. The instructions indicate minimum and maximum water level with the engine running or stopped. The water level mark should not be permitted to go below the applicable “low” water level mark.

Progressive lowering of the water in the gauge glass indicates a water leak in the cooling system, and should be reported. Normally, there should be no need to add water to the cooling system, except at extended intervals.

MAINTENANCE

FILLING THE COOLING SYSTEM

The coolant used in the engine cooling system should be made up and tested in accordance with the

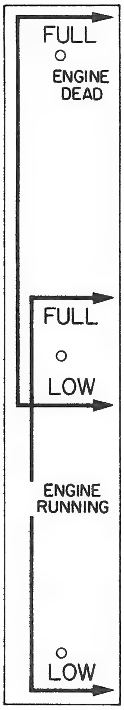

Fig.3-6 – Typical Water Level Instruction Plate

coolant Maintenance Instruction listed on the Service Data page.

When filling a dry system, remove the pressure cap and fill system through the water fill pipe. Before removing the water tank pressure cap, first pull down and hold the fill/relief valve handle until the air stops blowing. Do not attach a water hose to the fill pipe before relieving system pressure. When adding water to the system through the filler pipe connector, the fill/relief valve handle should be held down. This connection should be used only when adding small amounts of water.

WARNING

Do not overfill the tank. Overfilling can result in frozen radiators, and can constitute a hazard to personnel.

After filling a dry or nearly dry system, the engine should be run, with the filler cap removed, or the fill/relief valve opened, to eliminate any air pockets in the system. After running the engine, check the water level and if necessary add water to the system.

NOTE

Draining the cooling system will trip the low water shutdown device; therefore, when filling the cooling system the low water reset button must be pressed before engine start.

After filling operations have been completed and before starting the engine, the pressure cap must be replaced.

DRAINING THE COOLING SYSTEM

The engine cooling system should be drained *immediately* in the event that the diesel engine is stopped and danger of freezing exists. The draining procedure is as follows:

DRAIN ENGINE COOLING SYSTEM

1. Open the water drain located in engine drain sump, governor end of engine.

   The valve is tagged as noted and open when handles are in line with piping.

2. After system pressure is released, remove the water tank fill cap to allow drainage at an increased rate.

CAUTION

If a hot engine is drained, always allow the engine to cool before refilling with fresh coolant.

DRAIN FLUSH TOILET (IF SO EQUIPPED)

1. Flush toilet until all water has drained from tank.
2. Turn off electric toilet tank heater (if so equipped).
3. Remove pipe plug from bottom of toilet flush piping.

DRAIN WATER COOLER (IF SO EQUIPPED)

1. Remove and empty water bottle.
2. Drain remaining water in cooler by holding in the spigot button.
3. Turn off electric power to water cooler (if so equipped).

TESTING AUTOMATIC DRAIN VALVE AND SYSTEM OPERATION

To verify operation of the Auto-Drain Valve *only*, perform the following procedure:

1. Shut engine down (if running).
2. If necessary, close automatic cooling system drain circuit breaker, and crank engine to reset system.

3. Manually operate test switch mounted on auto-drain valve.

NOTE

Auto-drain valve should immediately activate causing cooling water to rapidly drain out (if cooling system has water in it). If cooling system has been drained, a loud sound will signify proper operation of the auto-drain valve.

Releasing of the test switch should cause the auto-drain valve to immediately terminate draining (or generate a sound signifying closing action in the case of a drained unit). Observe the drain port, within a few seconds no water should be noted.

To verify operation of the Automatic Cooling Water Drain *System*, perform the following procedure:

1. Shut engine down (if running).
2. Close automatic cooling system drain circuit breaker.
3. Remove retaining clip over auto-drain thermostat and swing thermostat out of well. (Do not disconnect electrically.)
4. Place metal base of thermostat in a pan of water chilled to 4.4° ± 1.1° C (40° ± 2° F).
5. Within a few seconds, the auto-drain valve should activate and begin to drain the cooling system.
6. To terminate the draining of the cooling system push the cold water fill switch mounted on the side of the A.C. cabinet.

NOTE

This step also checks the cold water fill circuit.

7. When the cold water fill switch is pressed, an alarm should sound in the cab and the WATER DRAIN DISABLED light should be energized.
8. To quiet the alarm bell and reset the automatic cooling water drain system, restart the engine.
9. With the engine idling, push the cold water fill switch; the alarm and light should once again come on.
10. Attempt to throttle out the locomotive, it should remain in idle regardless of throttle position.
11. Shut engine down, reinstall thermostat in auto-drain valve, and re-energize starting motors (or start engine) to again re-arm the cooling water drain system.

OBTAINING AN ENGINE WATER SAMPLE

When a sample of engine coolant is desired, it should be obtained with the engine warm and running. The coolant should be taken from a point where water flow is turbulent. Allow the water to run a few seconds to drain off any accumulated sediment.

TESTING ENGINE WATER TEMPERATURE SWITCHES

It is recommended that a routine check of temperature switch operation be made at the intervals specified in the Scheduled Maintenance Program. A thermometer well is provided in the temperature switch manifold to facilitate testing.

Temperature switches, Fig. 3-7, are easily removed from the temperature switch manifold and replaced with new switches. If a replacement switch with a new gasket attached is held at a ready position, the old switch and gasket can be removed and the new switch inserted with only a small loss of engine coolant.

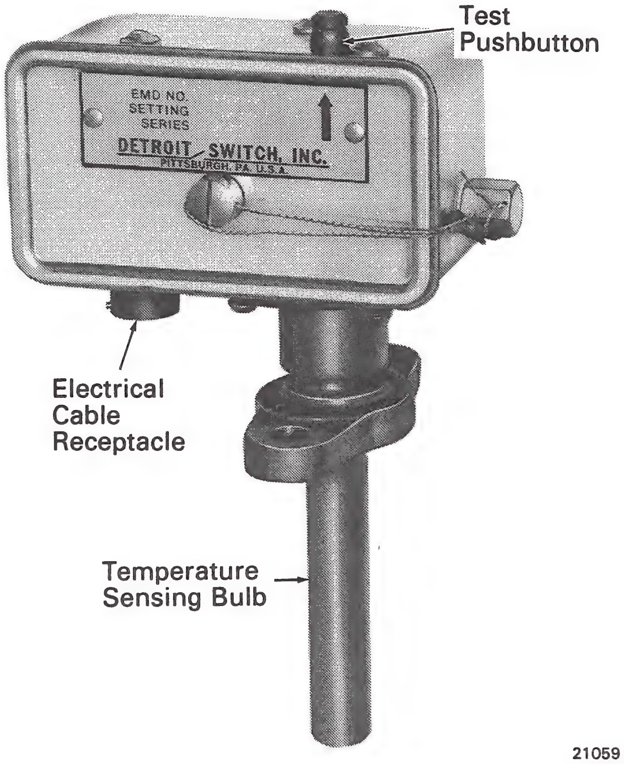

Fig.3-7 – Engine Temperature Switch

On the locomotive, pickup and dropout of temperature switches can be checked by placing a thermometer along with some oil or water in the well located in the temperature switch manifold, Fig.3-2, and loading the locomotive engine.

Operate engine under load until STS and shutters open. Record temperature at thermometer in switch manifold.

Apply jumper between TB81L10 and TB82L8 in the engine accessory control cabinet to close the shutters. Continue to run engine under load until ETS closes as indicated by hot engine alarm and indicator light. Record temperature and remove jumper between TB81L10 and TB82L8 to open shutters.

As temperature decreases ETS drops out and the alarm stops. Record ETS dropout temperature, and reduce throttle to Run 5 and place the generator field switch in the OFF position to drop load. Record engine water temperature when STS closes and shutters close.

The correct part numbers for replacement switches are listed on the Service Data page and in the "Locomotive Wiring Running List," supplied with the locomotive wiring diagrams. The part number for the running list itself is referenced in the lower right corner of the wiring diagram.

After replacement switches are installed and the engine is running, press the switch test pushbuttons in sequence to verify shutter and alarm operation.

Instructions for checking the temperature switches are referenced on the Service Data sheet, and plans for construction of bench testing apparatus can be obtained from the EMD Service Department upon request. Note that in any test of temperature switches, critical factors such as circulation of the test bath to prevent stratification, immersion of the temperature bulb to a proper depth, and ambient temperature approximating engineroom conditions must be observed.

INDICATIONS OF FAULTY SWITCH OPERATION

1. False hot engine indication due to incorrect ETS pickup.

2. Low oil shutdown due to hot engine oil. A fault exists in the cooling system and ETS did not operate properly.

NOTE

Hot lube oil can be caused by a plugged lube oil cooler. In such case a hot engine alarm will precede the hot oil shutdown.

3. A cold engine may result from sticking temperature switch pushbuttons.

INSPECTION AND CLEANING OF RADIATORS

The access covers between the engineroom and the radiator compartment must always be securely bolted in place during locomotive operation. If a cover is not in place, improper circulation of cooling air will result, and the slight pressurization of the engineroom provided by cooling air from the main generator will be lost.

Periodic inspection and cleaning of the radiators should be performed at the minimum intervals called for in the Scheduled Maintenance Program, at more frequent intervals as determined by operating conditions, or when trouble is suspected. Since the pressurized system will rarely require addition of water, any progressive lowering of the water level indicates that an inspection should be made for leaks. Inspect carefully for small leaks called "weep" at the junction of the radiator tubes and header.

Normally, the application of clean dry compressed air to the top surface of the radiators, followed by cleaning of the fan compartment, will satisfactorily clean the radiator cores and radiator compartment.

COOLING SYSTEM PRESSURE CAP AND FILLER NECK

The pressure cap and filler neck should be inspected, tested, and rebuilt or replaced at intervals indicated in the Scheduled Maintenance Program. Refer to the Service Data page at the end of this section for replacement part numbers.

INSPECTION AND REPLACEMENT

1. If the pressure cap bell housing or other metal surfaces are bent, replace the cap with a new cap, Fig. 3-8. Seal cooling system after filling if required by railroad rules.

2. If the filler neck sealing surface is damaged or distorted, replace the neck assembly with a new assembly. Use a new tank-to-neck gasket. Secure with four 3/8"-16 bolts and lockwashers.

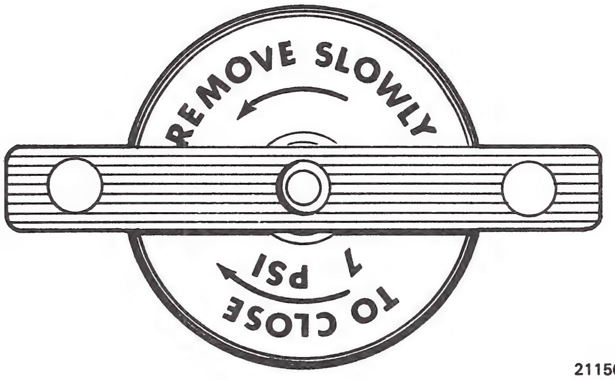

Fig.3-8 – Pressure Cap Assembly

3. If seals are hardened or damaged replace the cap with a new cap.

NOTE
Rebuild of pressure caps is not recommended.

Perform pressure test to qualify pressure cap and filler neck.

COOLING SYSTEM PRESSURE TESTING

Male quick disconnect fittings are provided on the water tank and in the air system piping at the equipment panel located below the water tank. A locally fabricated testing apparatus, Fig. 3-9, can be used to pressurize the cooling system with main reservoir air while the diesel engine is running and coolant is at normal level.

WARNING
Do not subject the water tank to pressure greater than 334 kPa (50 psi).

1. Using the testing apparatus, operate the ball valve to gradually pressurize the cooling system to about 83 kPa (12 psi). Tolerances for the 48 kPa (7 psi) pressure cap are as follows:

   Minimum Opening Pressure –

   34.5 kPa (5 psi)

   Maximum Opening Pressure –

   55 kPa (8 psi)

2. Close the ball valve and observe the pressure gauge. Pressure should drop slowly until the pressure cap closes. Pressure should then remain constant. Gauge pressure is the cap opening pressure.

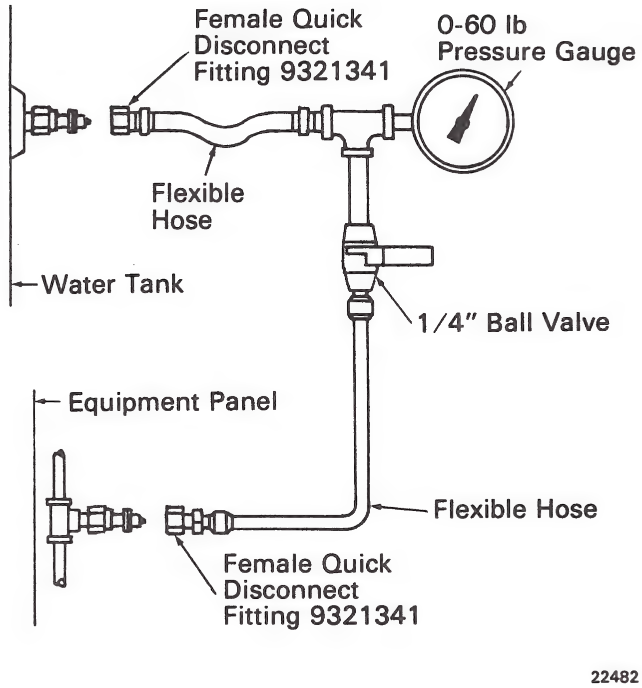

Fig.3-9 – Cooling System Pressure Test Apparatus

3. If cap opening pressure is not within the allowable tolerance, replace the cap with a new cap and repeat the test.

4. If gauge pressure does not remain constant, the pressure falls below the allowable minimum, perform the following.

   a. At the discharge end of the water tank overflow pipe, place a container of water so that the water level is above the end of the pipe. Observe for air bubbles. The presence of air bubbles indicates a defective cap. Relieve system pressure, replace the cap with a new cap, and repeat the test.

   b. At intake end of the water fill pipe, place a container of water so that the water level is above the end of the pipe. Observe for air bubbles. The presence of air bubbles indicates a defective fill/relief valve. Relieve system pressure, replace the valve with a qualified valve, and repeat the test.

5. If Steps a and b above do not detect or eliminate leakage, as indicated by a continuing drop in gauge pressure, inspect the filler neck assembly and gasket, radiator, and cooling system piping connections.

COOLING FAN V-BELT TENSION

The radiator cooling fan is driven by the engine through a matched set of seven V-belts. Proper belt tension is very important to efficient cooling system operation and long belt life.

Belt tension of each belt should be checked using a belt tension checker, Fig. 3-10, by applying a force of 4.5 kg (10 lbs) minimum to 6.8 kg (15 lbs) maximum with the tension tester located at the center of the belt span between the upper sheave and the idler, Fig. 3-11, to obtain a belt deflection of 6.5 mm (1/4").

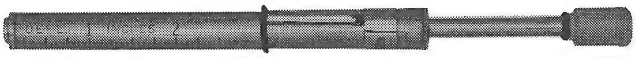

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Fig.3-10 - Belt Tension Tester

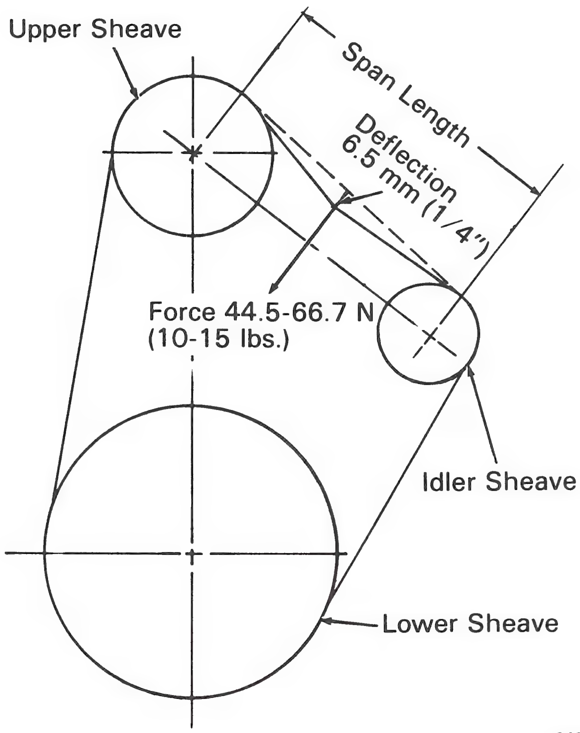

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Fig.3-11 - Checking Belt Tension

If too much tension is applied, the fan drive bearings may be damaged. The belts are operated too loosely, they will slip and overheat.

Either of these conditions will cause V-belt and pulley life to be seriously shortened. If one or more of the belts cannot be adjusted to the proper tension limits by repositioning of the idler pulley, the belts may be either too large or too small. Mismatched belts will not equalize the load on the belts. This will result in the shorter belts carrying most of the load and the longer belts only riding. A mismatch may result in the complete failure of a set.

Belt tension should be checked at intervals stipulated in the Scheduled Maintenance Program.

When applying a new or used set of matched V-belts, the center distance between the upper sheave and the idler sheave, Fig. 3-12, must be reduced sufficiently by loosening the four bolts holding the idler bracket to the idler support, thereby removing the tension applied to the belts by the idler sheave. This will permit the V-belts to pass freely over the pulleys. Any attempt to force the V-belts over the pulleys into the grooves without removing the tension can result in ply breakage and belt cover damage thus decreasing belt service life. After the belt set is installed, the idler sheave should be re-tightened so that there is no more than 13 mm (1/2") belt deflection at the center of the span and the drive should then be run for about one hour. This allows the belts to become well seated in the pulley grooves and equalized on both sides of the drive before actually checking the tension.

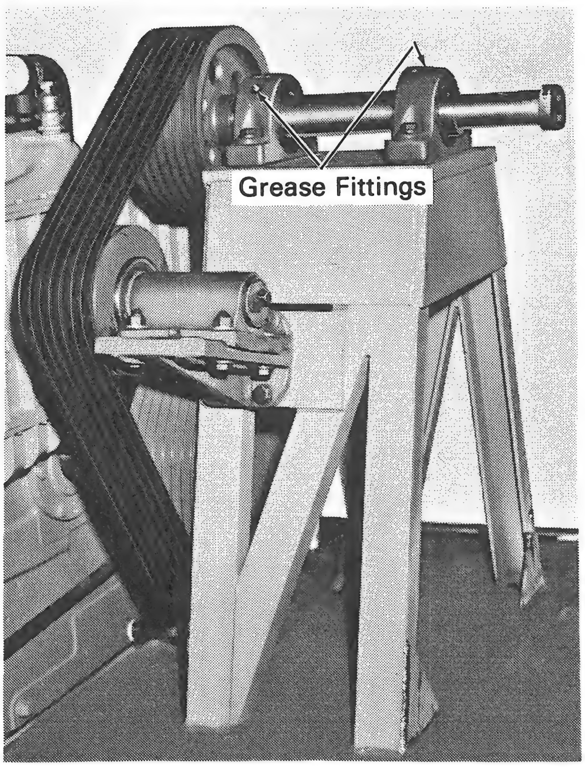

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Fig.3-12 - Cooling Fan V-Belt Drive

A code number is stenciled on the surface of each belt. All belts in a set MUST bear the same code number. The correct belt set number is listed on the Service Data page.

When new belts have been installed, the tension should be rechecked in accordance with the appropriate Maintenance Instruction listed on Service Data page.

LUBRICATION OF FAN PEDESTAL BEARINGS

The fan pedestal bearings are not permanently lubricated and must be regreased at intervals specified in the applicable Scheduled Maintenance Program with Shell NLG1 No. 2 EP Lithium base or Texas Marfax multi-purpose No. 2 Lithium base grease or equivalent. The amount of grease applied to the new bearing should be limited to approximately four strokes with a portable grease gun.

SERVICE DATA

COOLING SYSTEM

REFERENCES

Differential Pressure (Delta P) Combination Engine Protector	M.I. 260
Water Cooling Radiators	M.I. 549
Lube Oil Coolers	M.I. 927
Cooling Fan V-Belt Tension SW1000, SW1001, SW1500	M.I. 1216
Engine Coolant	M.I. 1748
Temperature Sensitive Switches	M.I. 5511

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

	Part No.
Automatic Drain Valve Assembly	9523127
Low Water Detector Qualification And Testing Apparatus	8349133
Temperature Switch-To-Manifold Gasket	8314926
Water Tank Pressure Cap Assembly	
48 kPa (7 psi)	9087321
83 kPa (12 psi)	9082206
Filler Neck Assembly	8458052
Tank-To-Neck Gasket	8424925
Cooling Fan V-Belt Set	8370971
Belt Tension Tester	8396624
Grease For Pedestal Bearings (14-1/2 oz. Cartridge)	8413019

SPECIFICATIONS

Temperature Switch Settings

Switch	Pickup	Dropout	Part No.
STS	79.5 ± 1.6°C (175 ± 3° F)	71 ± 1.6° C (160 ± 3° F)	9080882 or 9080821
ETS	93.3 ± 0.8° C (200 ± 1.5° F)	87.8 ± 1.1° C (190 ± 2° F)	9080881 or 9080822

Cooling Fan Belt Tension at 6.5 mm (1/4″) deflection . . . . 4.5 kg (10 lbs) Min.
6.8 kg (15 lbs) Max.

CENTRAL AIR SYSTEM

DESCRIPTION

Air is drawn into the carbody (hood) of the locomotive to supply two separate systems.

1. Engine cooling system.

2. Central system for motor and generator cooling and engine fuel combustion.

This section of the locomotive service manual covers the central system.

Air enters the carbody through sixteen (16) panel type filters which are mounted in frames on the hood doors adjacent to the traction motor and generator blowers and engine air intake. Eight (8) filters are located on each side of the hood, Fig. 4-1.

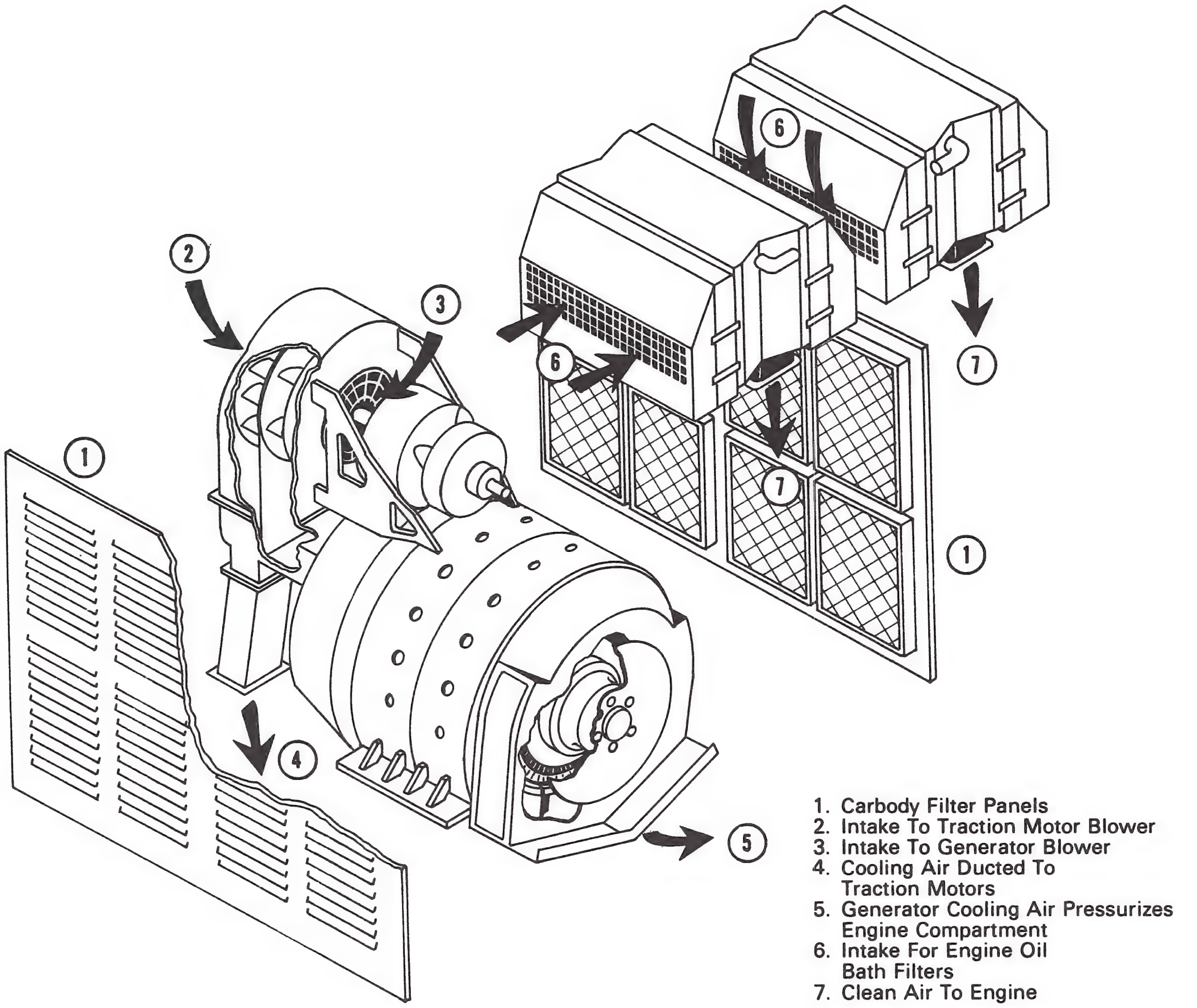

Fig.4-1 – Central Carbody Air System

CONSTRUCTION AND OPERATION OF PANEL TYPE CARBODY FILTERS

The panel type carbody filters are 51 mm (2″) thick fiberglass pads enclosed within a steel frame and protected by a coarse screen. Air being drawn through the filter impinges on the fiberglass pads which causes it to change directions many times. In order to remove and hold air-borne contaminants such as dust, dirt, and sand, the fiberglass pads are oil wetted on one side.

In operation, air flows through the filter, and the air-borne contaminants impinge upon the coated surfaces of the fiberglass. These surfaces hold the dust and dirt particles while the clean air passes through the filter.

INSPECTION AND MAINTENANCE OF PANEL TYPE CARBODY FILTERS

The effectiveness of impingement type filters is entirely dependent upon their ability to hold contaminants on the coated filter surfaces. As these surfaces become "loaded" with dust and dirt, the cleaning efficiency is reduced to a point where ultimately, the dirt laden air will be permitted to pass through the filter. It is also possible for the filters to become "loaded" to the point that they actually become plugged. This not only could allow unfiltered air to bypass the filters, but could cause a reduction in air supply to the blowers which, in turn, could result in damage to motors and generators, due to overheating.

To retain high filter efficiency they should be changed at the intervals stipulated in the Scheduled Maintenance Program. When applying new filters, ensure that the oil wetted side of the element is installed away from the door air inlet openings.

The filters are retained in their frames by spring clips and are easily removed, Fig. 4-2.

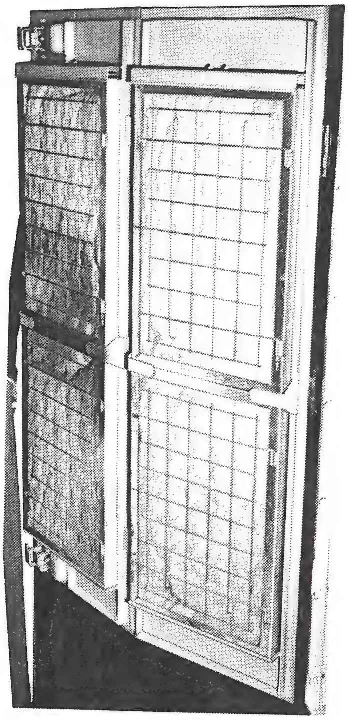

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Fig.4-2 – Carbody Filters Installed

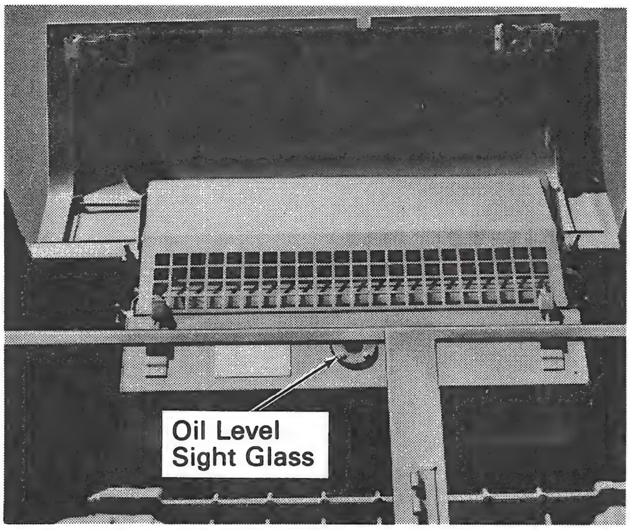

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Fig.4-3 – Engine Air Filter

ENGINE AIR FILTER

GENERAL DESCRIPTION

An engine air filter is mounted on both sides of an adapter which is secured to the top of each blower on the engine, Fig. 4-3. The engine air filter is an oil bath unit that relies upon oil-wetted media to remove dirt particles from the air that is drawn through it. The filtering media is both wetted and washed by filter oil that is drawn up to the filtering media.

FILTER OPERATION

Air is drawn in through an opening in the front cover of the panel, see Fig. 4-4. Here it strikes against an air deflector which divides the air so that a portion is diverted downward to the oil supply chamber. The air that has been diverted downward picks up oil and delivers it to the filter media before entering the engine. The balance of the incoming air supply goes through the oil wetted media where air-borne contaminants are deposited by impingement.

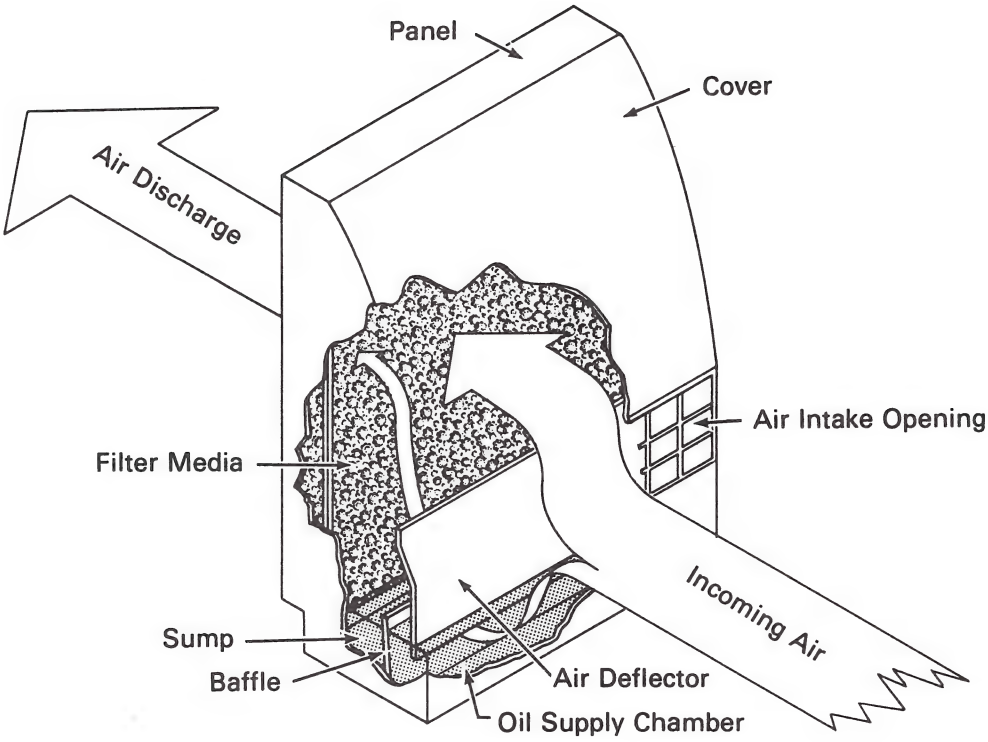

Fig.4-4 – Panel Type Oil Bath Filter

The constant flow of oil droplets down through the filter media carries dirt particles to the sump where they can settle and be subsequently drained away. This type filter, therefore, provides a self-cleaning action during operation.

MAINTENANCE

Operation of the engine oil bath filters should be checked at intervals stipulated in the Scheduled Maintenance Program. Filter oil should be changed and the filters cleaned at stated intervals or at shorter intervals if operating conditions warrant. Filter oil must be of the type indicated on the Service Data page. During filter changeout, inspect filter and housing structure for cracks or other physical damage.

OIL LEVEL

A sight glass, Fig. 4-3, is located at the lower front portion of each filter. Oil level after the engine has been shut down for a half hour should be at the center of the sight glass. If frequent addition of oil is necessary, an investigation should be made to determine where the oil is being lost.

Under normal conditions, there should be no need to add oil between scheduled oil changes.

CLEANING THE FILTER

At prescribed intervals, the drain plugs should be removed and the filter sumps drained of all oil and sludge.

After draining and replacing plugs, refill with oil to proper level through the opening provided in the front cover.

The entire filter panel assembly should be removed from the adapter for thorough cleaning. With the front cover removed, the filter media is exposed and should be washed with hot water. It should then be totally immersed in an alkaline or solvent type cleaner to loosen imbedded dirt from the filter media and oil sump.

After cleaning, again wash with hot water to remove all traces of cleaning solution. Then dry with air, inspect carefully and reinstall using a new filter to adapter gasket. (See Service Data pages.) Fill with oil and the filter is ready for another service cycle.

FIBERGLASS BAG-TYPE ENGINE AIR FILTERS (SPECIAL ORDER)

A fiberglass bag-type engine air filter can be supplied in place of the oil bath filter. The fiberglass bag-type elements are designed for a 90 day changeout interval.

SERVICE DATA

CENTRAL AIR SYSTEM

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

	Part No.
Engine Air Filter To Adapter Gasket	8351427

SPECIFICATIONS

Carbody Panel Filters (Disposable)	8380459
Engine Oil Bath Filter	8356190
Oil Capacity (Approximately)	7.6 litres (8 qts.)
Above 32.2° C (90° F)	SAE 40
Between 0° C and 32.2° C (32° F and 90° F)	SAE 20
Below 0° C (32° F)	SAE 10

ELECTRO-MOTIVE

LOCOMOTIVE SERVICE MANUAL

COMPRESSED AIR SYSTEM

DESCRIPTION

Compressed air is used for operating the locomotive air brakes and auxiliary devices such as sanders, shutter operating cylinders, horn, bell and windshield wipers. Air is also required for atomizing the fuel oil supplied to the steam generator (if so equipped).

AIR COMPRESSOR

DESCRIPTION

Air is compressed by a deep crankcase water cooled, three cylinder (six cylinder optional), two stage air compressor, Fig. 5-1. The compressor is driven through flexible couplings from the front end of the engine crankshaft.

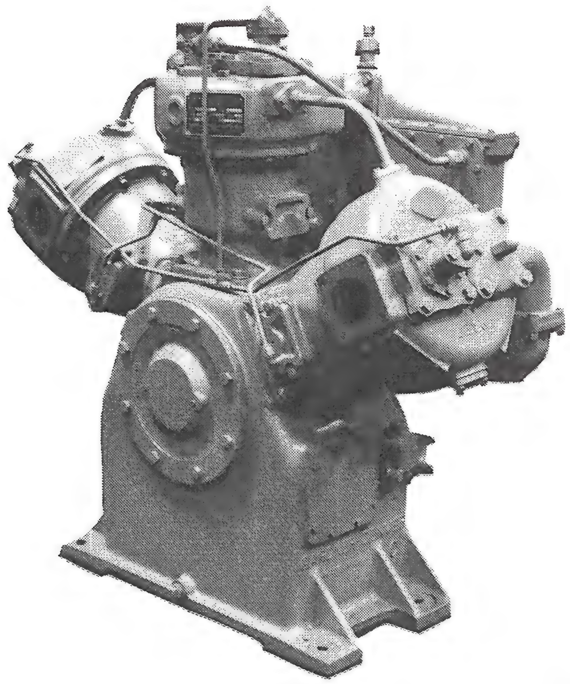

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Fig.5-1 – Air Compressor

The compressor has its own oil pump and pressure lubricating system. With the engine running, the oil level in the compressor crankcase can be checked on the float type indicator. At idle speed with the lubricating oil at operating temperature (60° C [140° F]), the oil pressure should be 124 to 172 kPa (18 to 25 psi). A plugged opening in the relief valve block is provided for an oil pressure gauge.

The compressor has two low pressure and one high pressure cylinders. The pistons of all three cylinders are driven by a common crankshaft. Two low pressure cylinders are set at an angle to the one vertical high pressure cylinder. Air from the low pressure cylinders goes to a water cooled intercooler to be cooled before entering the high pressure cylinder. The intercooler is provided with a relief valve and a plugged opening for a pressure gauge.

The compressor is equipped with either of two dry type air inlet filters, Fig. 5-2, containing replaceable elements.

MAINTENANCE

The air compressor should be periodically checked to see that the lube oil level indicator needle is in the RUN zone on the sight gauge. If the gauge shows the oil level to be in the ADD zone, a sufficient amount of EMD approved lube oil should be added at the oil fill pipe. The oil should be changed at intervals stated in the applicable Scheduled Maintenance Program. The addition of oil between changes is normally not necessary due to the high capacity of the deep crankcase.

When it is necessary to install a pressure gauge to check intercooler or lube oil pressures, be sure the gauge is removed and replaced with a plug and the plug tightened sufficiently to prevent loosening from vibration.

The air inlet filter element should be changed at intervals specified in the applicable Scheduled Maintenance Program. Consult the Service Data page at the end of this section for the correct replacement filter element.

To remove the element from the rectangular shaped filter, remove the nut, lockwasher, and retainer hook at the top and bottom of the filter, Fig. 5-3. The impingement screen can then be removed and the element pulled out of the housing.

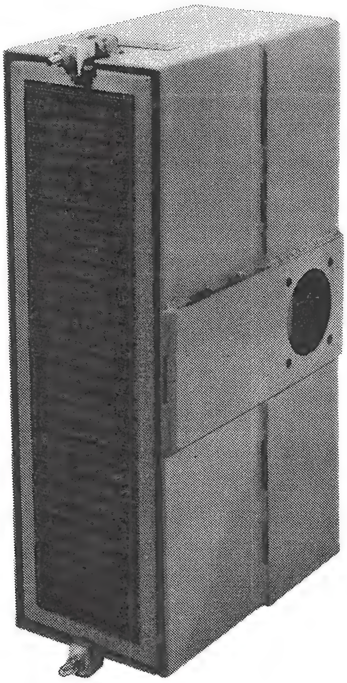

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Fig.5-2 – Compressor Air Filters

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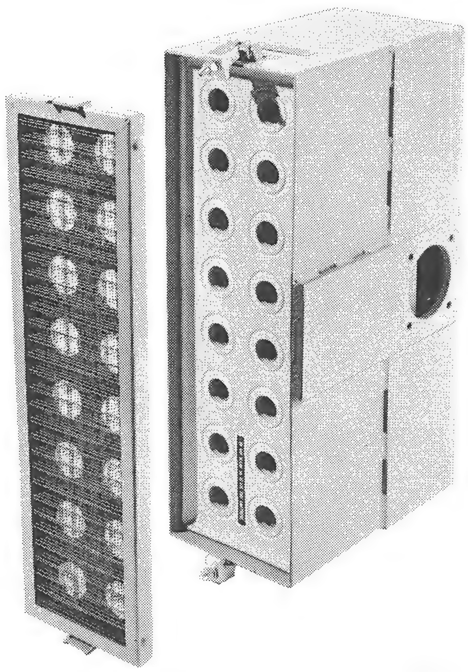

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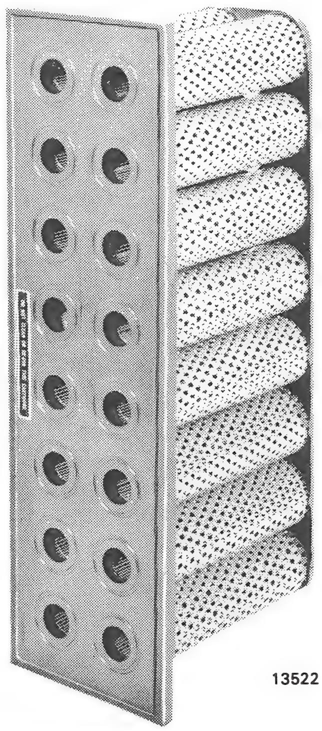

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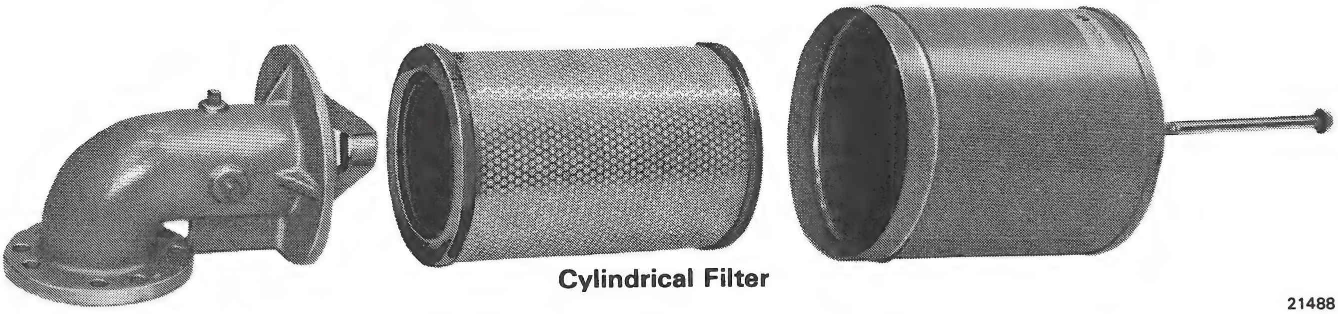
Rectangular Filter



Cylindrical Filter

21488

Fig.5-3 – Replacing Compressor Filter Element

To remove the element from the cylindrical shaped filter, remove the elastic stop nut and the retainer at the bottom of the filter. The element is then free to drop out of the filter body.

COMPRESSOR CONTROL SWITCH — CCS

DESCRIPTION

Since the air compressor is directly connected to the engine, the compressor is in operation (although not always pumping air) whenever the engine is running. An unloader piston that cuts out the compressing action when actuated by air pressure from the compressor control switch, Fig. 5-4, is provided in the head of each high and low pressure cylinder. The unloader accomplishes this by blocking open the intake valves in the high and low pressure cylinders. When the air operating the unloader is cut off, the unloader releases the intake valves and the compressor resumes pumping. Main reservoir air pressure is used to actuate the unloader valves.

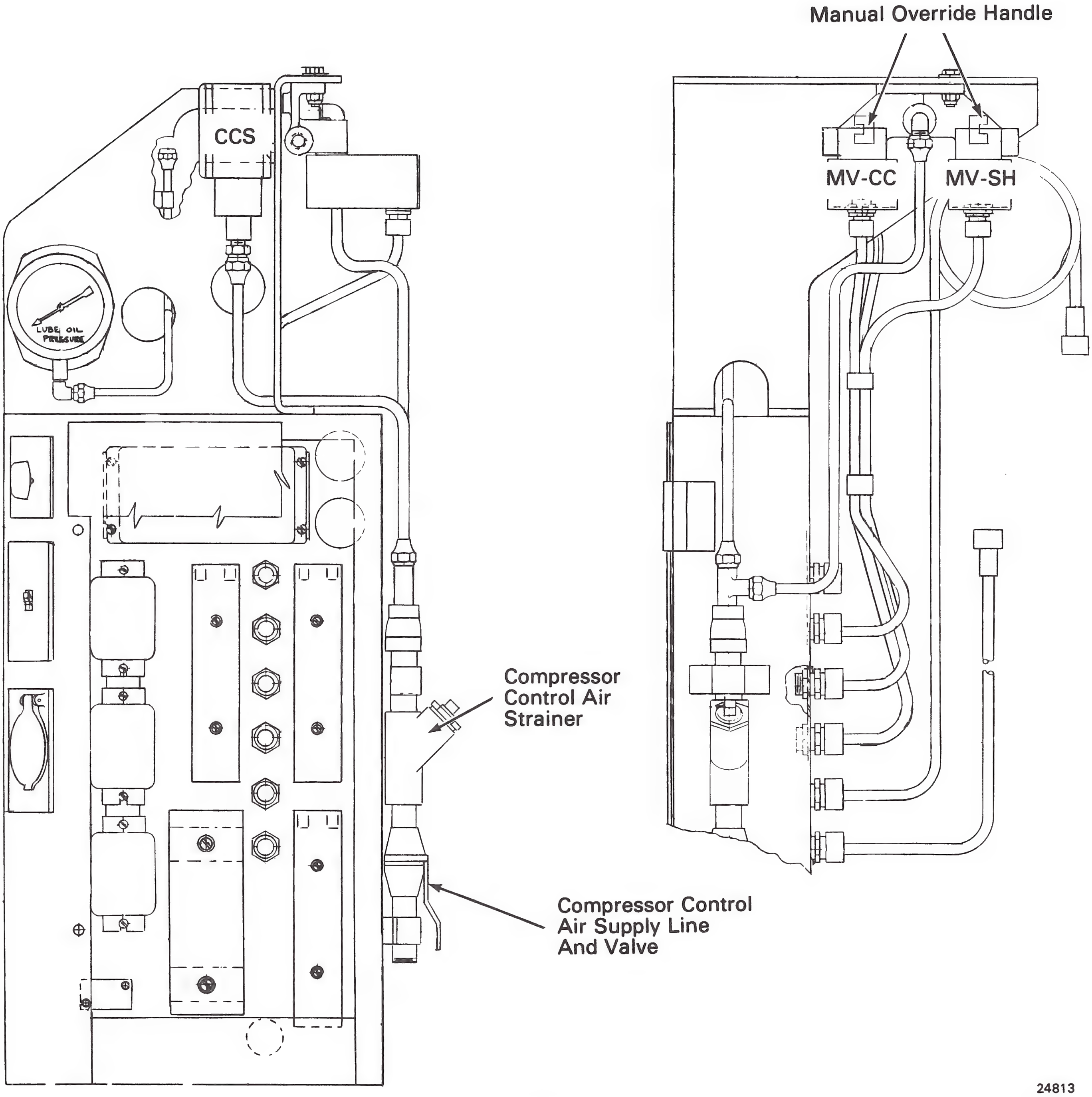


Fig.5-4 – Compressor Control Panel

When the locomotive is furnished with the optional extra compressor synchronization, each locomotive unit is equipped with an electro-pneumatic system for compressor governor control. The electrical arrangement is such that the compressor in each unit of a consist pumps air to its own main reservoirs whenever the main reservoir pressure in any single unit drops to 896 kPa (130 psi), Fig. 5-5. All units will continue to pump until main reservoir pressure in each and every unit reaches 965 kPa (140 psi).

Another available option is a dual compressor control switch, Fig. 5-5, which acts to unload the compressor on an individual unit when the main reservoir pressure for that unit reaches 1000 kPa (145 psi). This prevents individual compressors from working against the main reservoir safety valve when other units in the consist have not yet accumulated sufficient main reservoir pressure to signal unloading of the compressors.

MAINTENANCE

The compressor control switch, Fig. 5-6, is manufactured to close tolerances and therefore inspections should be limited to intervals specified in the applicable Scheduled Maintenance Program. If air compressor difficulties arise, all other sources of possible trouble should be investigated before any attempt is made to disturb the settings of the compressor control switch.

During periodic inspections of the compressor control switch or when faulty operation is suspected, the switch should be removed from the locomotive and replaced with a qualified switch. The faulty switch should be taken to a bench for any further testing or setting.

COMPRESSOR CONTROL MAGNET VALVE — MV-CC

DESCRIPTION

When the compressor control magnet valve, Fig. 5-4, is de-energized, the air compressor unloader piston lifts and the compressor begins to pump. The magnet valve is de-energized when the compressor relay is energized and the compressor relay responds to the compressor control switch in the individual unit or to the compressor control switch in each or any unit of a consist equipped with synchronization.

A manual means is also provided to keep the air compressor unloaded. The compressor magnet valve, MV-CC, can be held open by a manual override handle, which holds the magnet valve in energized position.

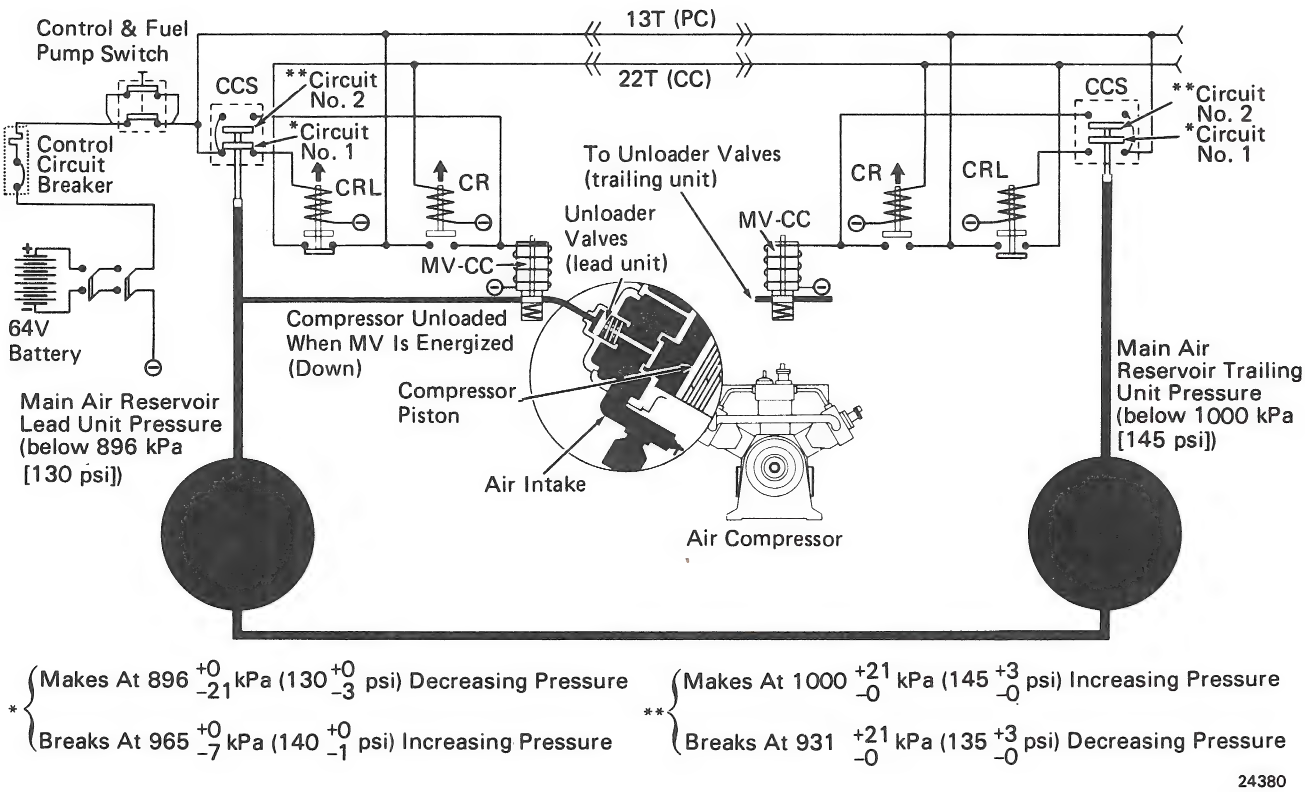


Fig.5-5 – Electro-Pneumatic Compressor Control

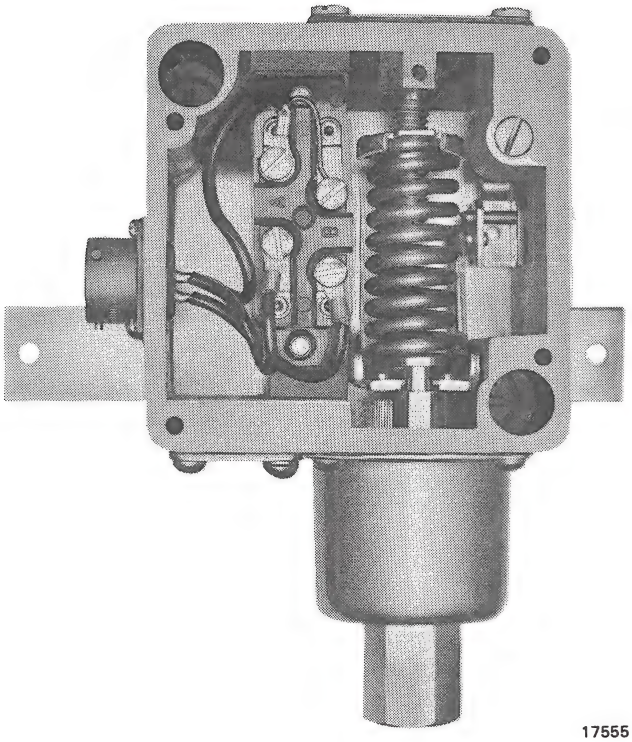


Fig.5-6 – Compressor Control Switch

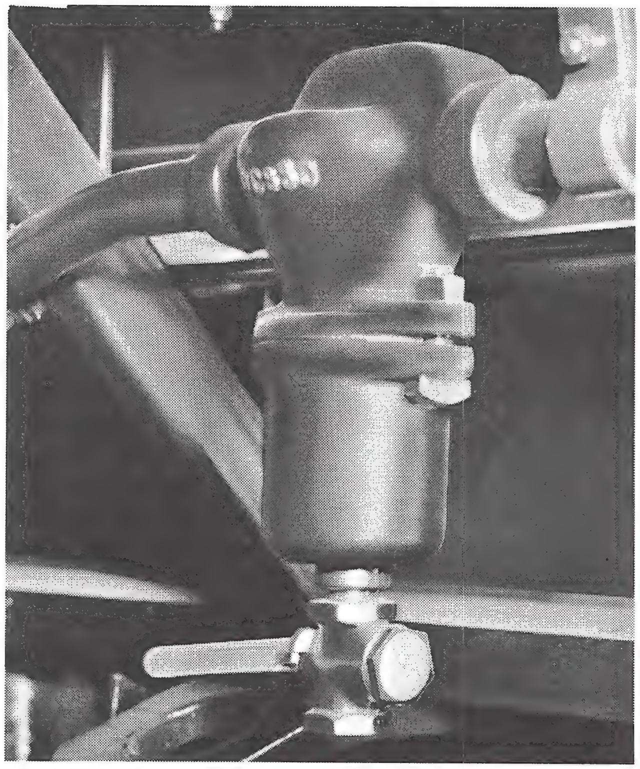


Fig.5-7 – Dirt Collector

MAINTENANCE

If faulty operation of the valve is suspected, check to see that the manual override handle is in the proper position. With the manual override handle pulled out and the magnet valve de-energized, the valve should close causing the compressor to pump. Check the magnet valve and air line to the compressor to pump. Check the magnet valve and air line to the compressor unloader valve for leaks. Also check the electrical connections on the valve to see that they are tight. If repair is required, remove the magnet valve and replace it with a qualified valve.

COMPRESSED AIR FILTERS

DESCRIPTION

The compressed air system has a dirt collector, Fig. 5-7, and a compressor control strainer, Fig. 5-8, to prevent moisture and contaminants from being carried into the air brake and other systems.

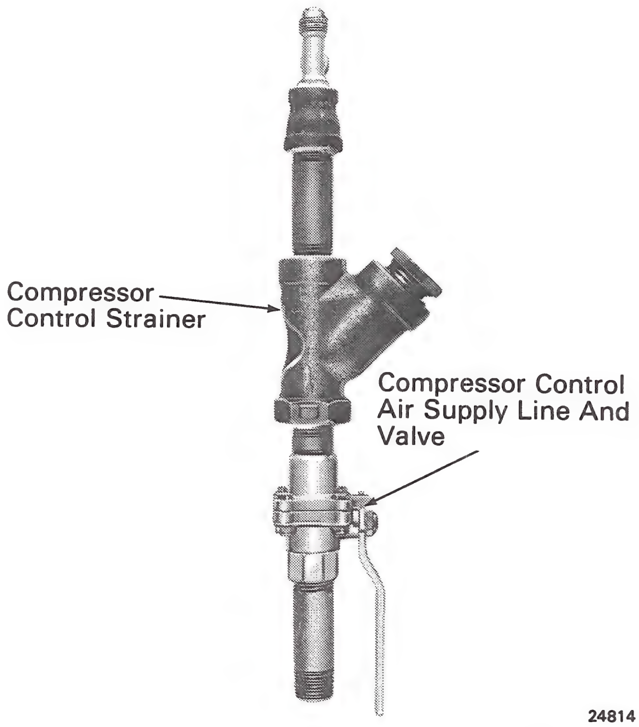


Fig.5-8 – Compressor Control Strainer

MAIN RESERVOIR DRAIN VALVES

DESCRIPTION

Both main reservoirs are equipped with manual drain valves, Fig. 5-9, to allow moisture to be drained from the reservoir before it is carried into the air system.

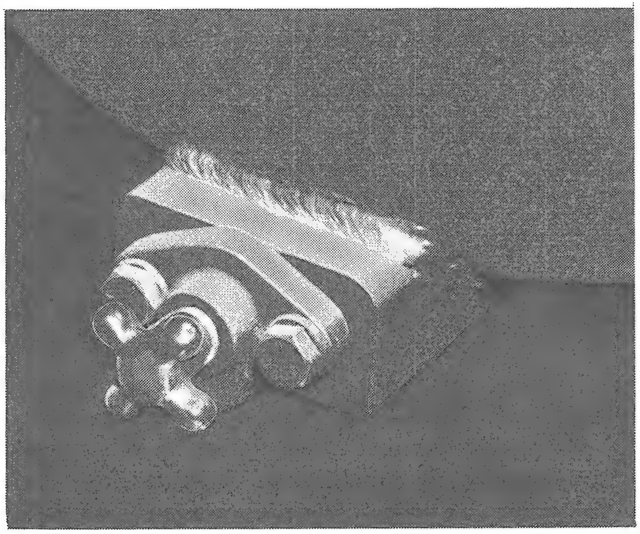


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Fig.5-9 - Manual Drain Valve

MAINTENANCE

The drain valves should be checked periodically to see if they are seating properly and that no air is leaking. The seals and piston should be lubricated at regular intervals with a good grade of air brake grease.

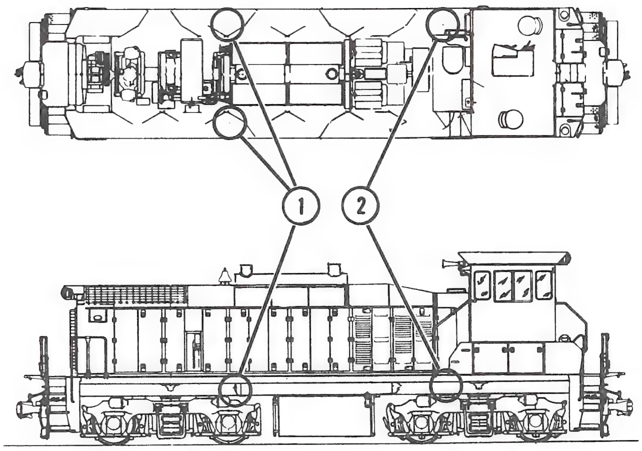
The compressed air system air filter and main reservoir manual drains should be operated at least once a day to ensure adequate draining of the system.

The location of each drain is shown in Fig. 5-10.

RADIATOR SHUTTER CONTROL

DESCRIPTION

The radiator shutters are opened and closed by the action of an air operated piston, which is mounted to the carbody frame above the shutter assembly in the fan compartment. The cylinder is actuated when the shutter control magnet valve, MV-SH, is energized.



1. Main Reservoir Drain Valve Locations
2. Main Reservoir Dirt Collector Drain Valve

24815

Fig.5-10 - Compressed Air System Drain Valve Location

MAINTENANCE

Operate the shutters manually by tripping the temperature switch STS or by manually operating the shutter valve mounted on the front of the water tank to the TEST position. Check for fast, snappy action when opening or closing, and for interference which might be caused by bent linkage or shutter blades. If shutters do not open or close to their full extent, the shutter operating rod may be adjusted by loosening the locknut on the operating rod at the front of the cylinder, and turning the rod until the desired length is obtained.

AIR BRAKE EQUIPMENT

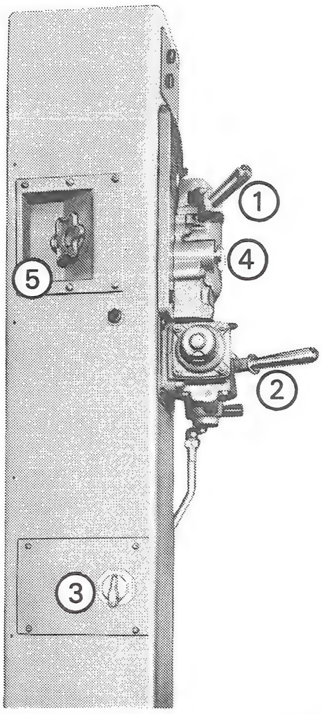
DESCRIPTION

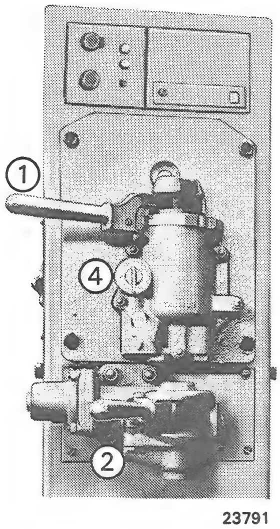
The basic locomotive is equipped with type 26NL air brakes. The 26NL air brake control equipment is located to the left of the controller. This equipment, Fig. 5-11, consists of an automatic brake, independent brake, multiple unit cutoff valve and a trainline air pressure adjustment device. The dead engine feature, Fig. 5-12, is a part of the 26NL equipment.

Some locomotives are equipped for non-multiple unit operation of the air brake which will not permit the air brake of the one locomotive to be controlled by another unit. Trainline air brakes are not affected by this. On these locomotives the MU-2A valve is omitted.

AUTOMATIC BRAKE VALVE

The automatic air brake valve handle controls the air to the locomotive and train brake systems and may be placed in any of six operating positions, Fig. 5-13.





1. Automatic Air Brake Handle
2. Independent Brake Handle
3. Multiple Unit Valve
4. Cut-Off Valve
5. Trainline Air Pressure Knob

Fig.5-11 – Typical Air Brake Equipment

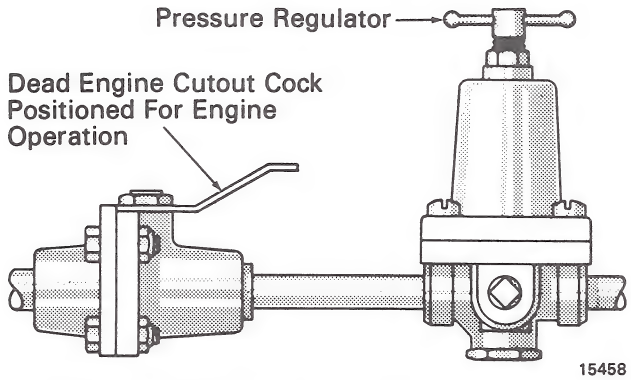


Fig.5-12 – Dead Engine Cutout Cock And Pressure Regulator

Provisions may be made for brake cylinder application and release rates in which the locomotive air brakes may be made to apply and release at the same rate as the cars trailing the locomotive. Control is through a switch on the engineer's control stand for either freight or passenger mode.

INDEPENDENT AIR BRAKE

The independent air brake handle is located directly below the automatic air brake handle. It has two positions; namely, RELEASE and FULL APPLICATION, Fig. 5-14. Between these two positions is the application zone. Since this is a self-lapping brake, it automatically laps off the flow of air and maintains brake cylinder pressure corresponding to the position of the handle in the application zone.

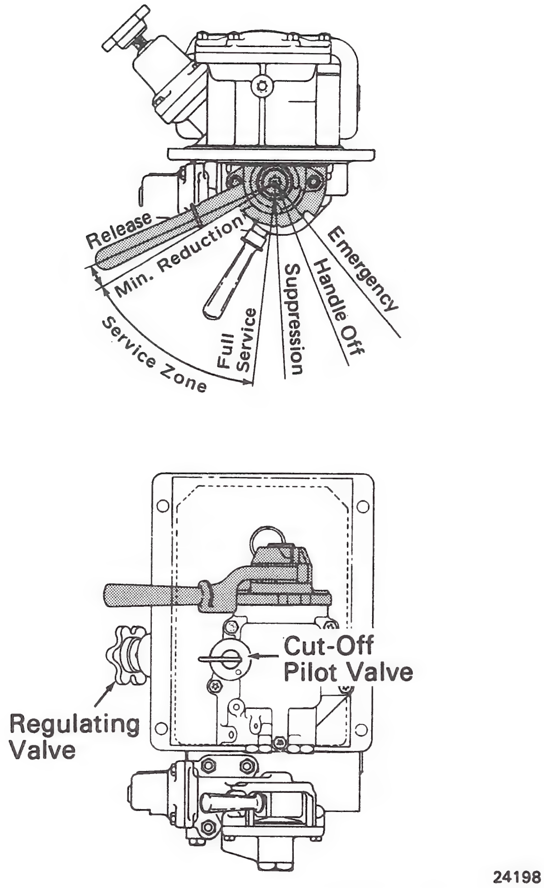


Fig.5-13 – Automatic Brake Handle Positions

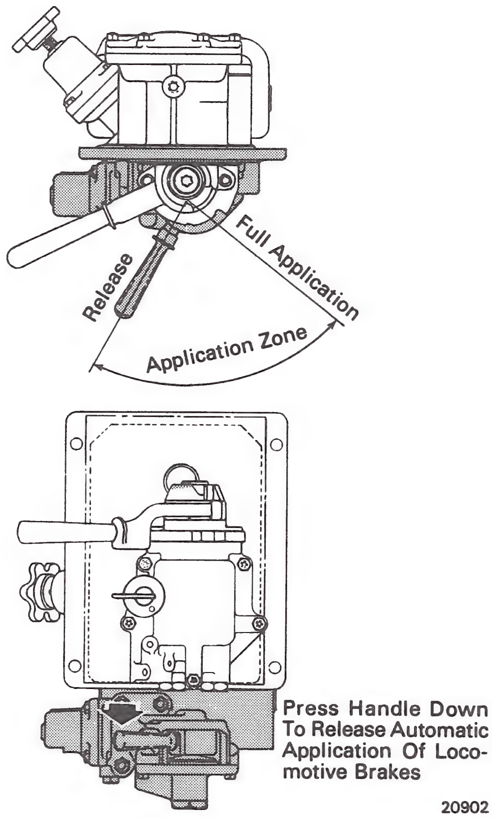


Fig.5-14 – Independent Brake Handle Positions

Depression of the independent brake valve handle when in the RELEASE position causes release of any automatic brake application on the locomotive.

MULTIPLE UNIT VALVE

The universal multiple unit (MU-2A) valve is located on the left hand side of the control stand as shown in Fig. 5-11. Its purpose is to pilot the F1 selector valve which is a device that enables the air brake equipment of one locomotive unit to be controlled by that of another unit.

The MU-2A valve has three positions.

1. LEAD or DEAD
2. TRAIL 6 or 26*
3. TRAIL 24

The valve is positioned by pushing in and turning to the desired setting.

*Whenever the MU-2A valve is in the TRAIL 6 or 26 position, and if actuating trainline is not used, then the actuating end connection cutout cock must be opened to atmosphere. This is necessary to prevent the unwanted loss of air brakes due to possible pressure buildup in the actuating line.

CUTOFF VALVE

The cutoff valve, Fig. 5-11, is located on the automatic brake valve housing directly beneath the automatic brake valve handle. This valve has the following three positions:

1. CUTOUT
2. FRT (Freight)
3. PASS (Passenger)

TRAINLINE PRESSURE ADJUSTMENT

The trainline air pressure adjusting knob, Fig. 5-11, is located behind the automatic brake valve at the upper portion of the brake pedestal.

DEAD ENGINE CUTOUT COCK

A dead engine cutout cock, Fig. 5-12, is provided as part of the 26NL brake equipment. When a locomotive is to be shipped dead in a train the cutout cock handle should be positioned as indicated in Fig. 5-15.

PRESSURE REGULATOR

The pressure regulator, Fig. 5-12, is provided to regulate the air pressure available for braking a locomotive being shipped dead in a train.

The pressure regulator is pre-set at the value given in the Service Data page. At any time the regulator must be reset, loosen the locknut and turn the adjusting handle on top of the regulator until the desired pressure is registered on the brake cylinder gauge when the brake is applied.

The pressure regulator should be cleaned out periodically by unscrewing the cleanout plug in the bottom of the regulator and removing and cleaning the screen.

BRAKE EQUIPMENT POSITIONS

When operating locomotives equipped with 26NL air brakes, the brake equipment should be positioned according to the information given in Fig. 5-15.

NOTE

For maintenance information consult the manufacturer of the specific air brake equipment provided.

SANDING SYSTEM

DESCRIPTION

Pneumatically controlled sanding is the basic system used, but since the locomotive may be operated in multiple with units that are equipped for electric control of sanding, trainlined electric control of sanding may be provided as an extra in addition to or instead of pneumatic control.

When the sanding switch level is operated, electrical energy is directed through interlocks of reverser switchgear to operate either the forward or reverse sanding magnet valves in all units of a consist. The basic switch may be operated in any direction for correct sanding and it is non-latching.

During wheel slip action, time delay relay TDS is energized to provide sanding on only the slipping unit. Delayed dropout of TDS causes sanding to continue for a timed period after the slip is corrected.

Type Of Service	Automatic Brake Valve	Independent Brake Valve	Cutoff Valve	Dead Engine Cutout Cock	26D Control Valve	26F Control Valve	MU2 Valve	Dual Ported Cutout Cock	Overspeed Cutout Cock	Deadman Cutout Cock
SINGLE LOCOMOTIVE EQUIPMENT										
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	In	Open	Open
Double Heading	Handle Off Position	Release	Cutout	Closed		Graduated Direct	Lead	In	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutout	Open	Relief Valve At Control Reservoir 73±2 lbs	Direct	Dead	In	Closed	Closed
MULTIPLE LOCOMOTIVE EQUIPMENT AND EXTRAS										
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	In	Open	Open
Trail	Handle Off Position	Release	Cutout	Closed		Graduated Direct	*Trail 6 or 26 Trail 24	Out	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutout	Open	Relief Valve At Control Reservoir 73±2 lbs	Direct Release	Dead	In	Closed	Closed
Double Heading	Handle Off Position	Release	Cutout	Closed		Graduated Direct	Lead	In	Open	Open
Dual Control:										
Operative Station	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	In	Open	Open
Non-Operative Station	Handle Off Position	Release	Cutout							

*Whenever the MU-2 valve is in "Trail 6 or 26" Position and if the actuating train line is not used, then the actuating end connection cutout cock must be open to atmosphere, to prevent the inadvertent loss of air brakes due to possible pressure buildup in the actuating line.

NOTE

By AAR standard all cocks in the brake pipe end cocks have handles perpendicular to pipe when open.

24816

Fig.5-15 – Air Brake Equipment Positions

Sanding during an emergency application of the brakes is accomplished electrically from all sand traps. The circuits from the switch are so arranged that emergency sanding from all traps will continue even though the motors are "plugged" (reverse lever placed to oppose direction of travel). Fig. 5-16 illustrates the sanding circuit.

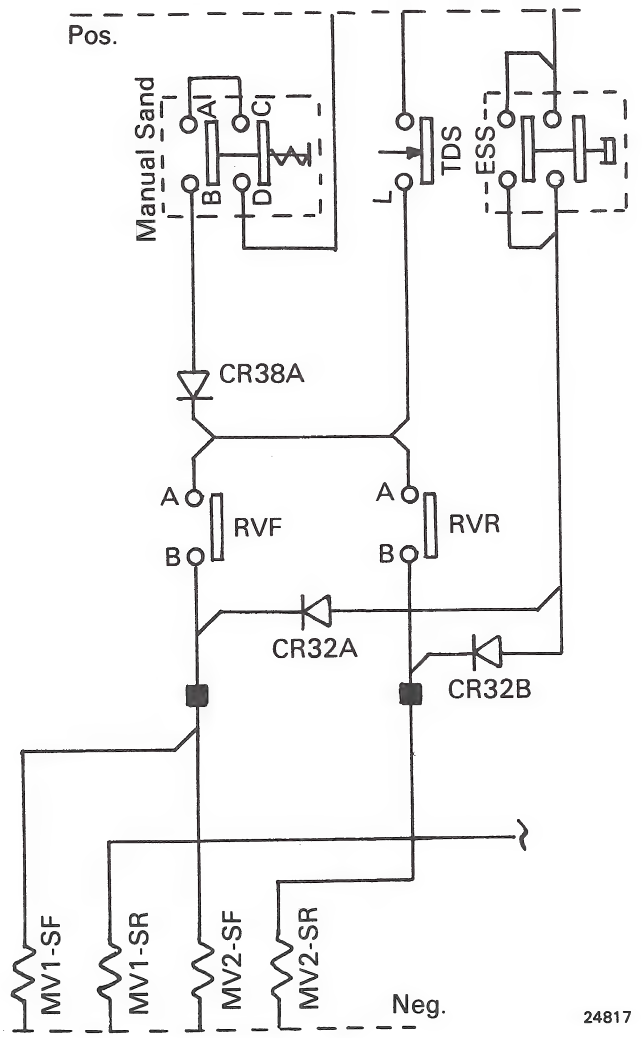


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Fig.5-16 - Sanding Circuit, Typical

MAINTENANCE

Before each trip check operation of the sanders by placing the reverser handle in the direction to be sanded. Close the throttle and move the manual sanding switch to the sand position. Check the sanding nozzles at the rail to make sure they are aligned correctly and that the sand is being delivered to the rail.

Extreme care should be taken that the proper grade of clean dry sand is used. Damp or dirty sand or sand with foreign material in it is likely to clog the traps.

SANDING CONTROL VALVE

DESCRIPTION

Two sanding control valves in each end of the locomotive, Fig. 5-17, one for forward and one for reverse sanding, provide metered main reservoir air to their respective forward and reverse sand traps. When an electrical signal is received, the magnet valve section is energized to open an air valve which allows the main reservoir air to be admitted to the sand traps. The electrical signal can be initiated by the manual sanding switch, a wheel slip or an emergency brake application.

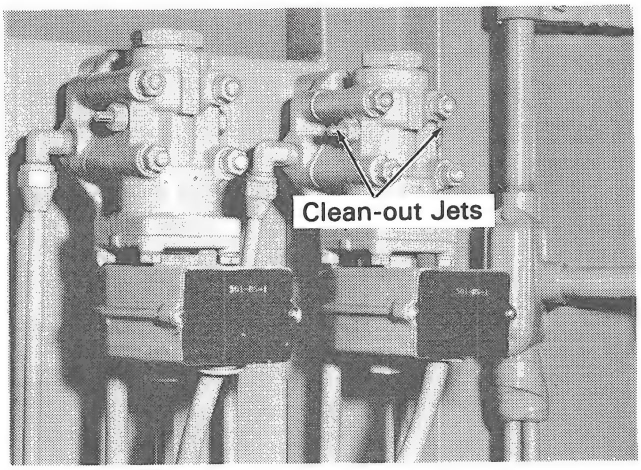

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Fig.5-17 - Sanding Control Valves

MAINTENANCE

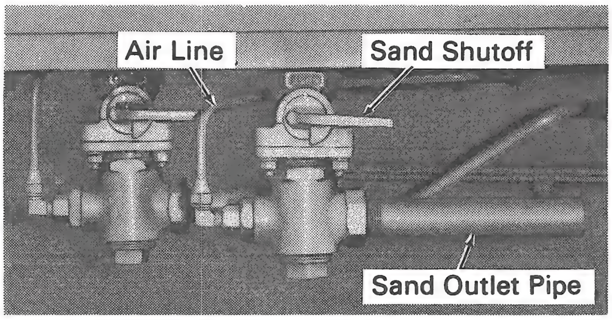
If faulty operation is suspected, inspect the electrical connections for tightness and inspect air connection for leaks. The control valve is equipped with automatic clean-out jets to clean out the orifice. To operate the clean-out jets push in the plungers on each side of the valve, Fig. 5-17. The plunger will automatically reset at the beginning of the next sanding cycle from the high pressure clean-out blast of air.

If further repair is required on the valve, remove it from the locomotive and replace with a qualified mechanism.

SAND TRAP

DESCRIPTION

Sand is fed to the trap, Fig. 5-18, by gravity through an inlet at the top of the trap. Actuating air enters the trap through the air nozzle. The nozzle is always covered by sand and therefore the air moves the sand that lies ahead of the discharge end of the



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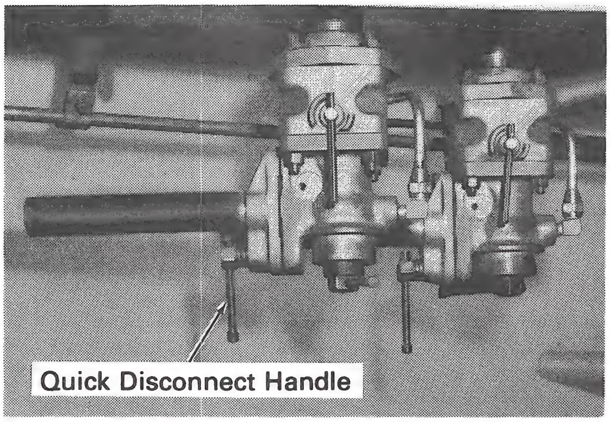

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Fig.5-18 - Sand Trap

nozzle. Sand entering at the trap inlet replaces the sand in front of the nozzle, thus a uniform flow of sand is delivered to the rail through the trap outlet.

A sand shutoff assemlby is mounted to the top of the trap at the sand inlet. The valve is in the open position when the hand lever on the side is set at OPEN or is parallel to the sand inlet line. The shutoff can be used when it is desirable to have a particular sanding line inoperative or if work is to be performed on the sand trap.

MAINTENANCE

Before any work is performed on a sand trap, the shutoff valve mounted to the top of the trap should be closed by turning the shutoff valve handle to a horizontal position.

Due to condensation there is always the possibility of getting moisture in the sand trap. To clean out the trap remove the pipe plug at the bottom of the trap. On special order a trap equipped with a quick disconnect delivery tube can be furnished.

The sand trap is set at the time of installation to deliver approximately 0.6 to 0.7 kg (20 to 24 oz.) of sand per minute. To change the rate of delivery, screw the adjusting nut, Fig. 5-19, in or out

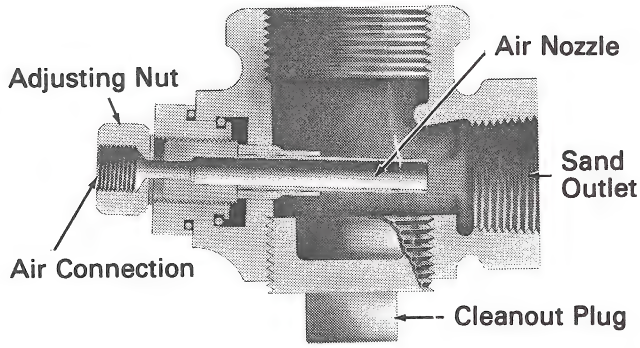

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Fig.5-19 - Sand Trap, Cross-Section

depending on whether more or less sand is desired. On the quick disconnect type sand trap use a 7/32" allen wrench to turn the sand control paddle to increase or decrease the rate of delivery.

AIR SYSTEM ACCESSORY EQUIPMENT

WINDSHIELD WIPER ASSEMBLY

DESCRIPTION

A separate wiper assembly is provided for each window in front and behind the operator's and helper's side of the locomotive cab and for the center windshield on the low nose cabs. The air motor, Fig. 5-20, used for the center windshield is identical to the other motors but is set for a longer degree of sweep.

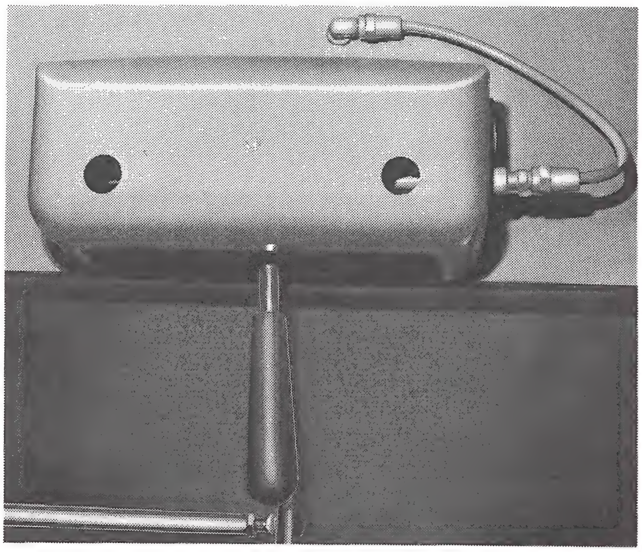

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Fig.5-20 - "Clean Cab" Windshield Wiper Air Motor

Each air motor is controlled by its own hand operated air valve which is located just above the side windows on each side of the cab. Each motor is equipped with a hand operated lever which can be used to operate the wipers in an emergency.

MAINTENANCE

If a windshield wiper air motor is not operating correctly, check to see that the air connections at the motor and the manual control valve are tight and free from leaks. With the air turned on, operate the air motor with the hand lever attached to the air motor shaft. If this fails, turn the air off and again try to operate the motor by hand. In most cases this will clean the valve seat of any foreign particles that may have been forced in through the air line.

Remove exhaust fitting, Fig. 5-20, and check for dirty filter or plugged hole. Remove reverser ball housing and check for broken or jammed ball spring.

Check the internal air flow by removing the cylinder end caps and blowing out the holes in the valve chamber. Also blow into the exhaust outlet to make sure the hole is not plugged.

If the air motor still does not operate properly, it will have to be replaced with a qualified motor and taken to the bench to be repaired.

If the wiper connecting arm must be removed from the air motor shaft, remove the acorn nut on the end of the shaft and pull the connecting arm off the splined shaft. When replacing the connecting arm on the shaft, be careful not to overtighten the acorn nut. The wiper motor and wiper mechanism are designed to operate at a maximum speed of 120 - 130 strokes per minute.

The speed of the wiper motor is adjusted by a set screw, Fig. 5-20, located in the exhaust restrictor. The following procedure should be used in making the adjustment:

1. Place a piece of paper between the wiper blade and the glass to simulate a wet glass condition which reduces frictional drag on the blades.
2. Make sure main reservoir air pressure is 896 kPa to 965 kPa (130 to 140 psi). Turn operating valve in cab to the fully open position.
3. Turn the adjusting screw in the exhaust restrictor until the wiper motor is running at 120 - 130 strokes per minute.

AIR HORN

DESCRIPTION

The basic air horn is a front facing diaphragm type air horn, Fig. 5-21. The air horn actuating lever is located on the brake stand at the locomotive control station. When the operating lever is pulled down, compressed air is supplied to the horn. Other types of air horns are available on special order including five chime horns.

16915

Fig.5-21 - Basic (Single Chime) Air Horn

A valve located in the air brake stand, provides a means for shutting off air supply to the horn operating lever.

MAINTENANCE

To inspect and clean the air horn diaphragm, remove back cover bolts and back cover. The diaphragm ring and diaphragm can be removed by taking out the diaphragm ring screws.

Whenever a back cover is removed, it is good practice to blow out the air lines by opening the air horn operating valve wide with full reservoir pressure on the line. This will also clean out the orifice dowel pin.

BELL

DESCRIPTION

The basic locomotive bell is located on the hood near the front stack of the locomotive. A positive action air valve, which activates the bell, is located on the air brake stand at the operator's control

station. When the valve is opened, compressed air forces the plunger in the bell ringer assembly down, which causes the clapper to strike the side of the bell.

When the plunger reaches the extended position, the compressed air then returns the plunger to its original position.

To shut off the air supply to the bell operating valve at the control stand, remove the upper panel on the back of the air brake stand and close the valve in the bell ringer air line.

MAINTENANCE

If the bell does not operate when the bell ringer operating valve at the control stand is opened, check to see that the clapper is free to swing and that no air leaks are present in the air lines.

If a new bell ringer cartridge, Fig. 5-22, is needed, remove the old cartridge by loosening the locknut on the side of the bell ringer assembly and backing out the set screw three or four turns. Using the clapper as a lever, unscrew the clevis from the assembly and pull the cartridge out with a pair of pliers. Before installing the new cartridge, actuate the bell ringer operating valve a few times to blow out any dirt or scale which may have accumulated. After installing the new bell ringer cartridge, be sure the "O" rings are in place before applying the clevis. Once the clevis is applied, tighten the set screw and locknut.

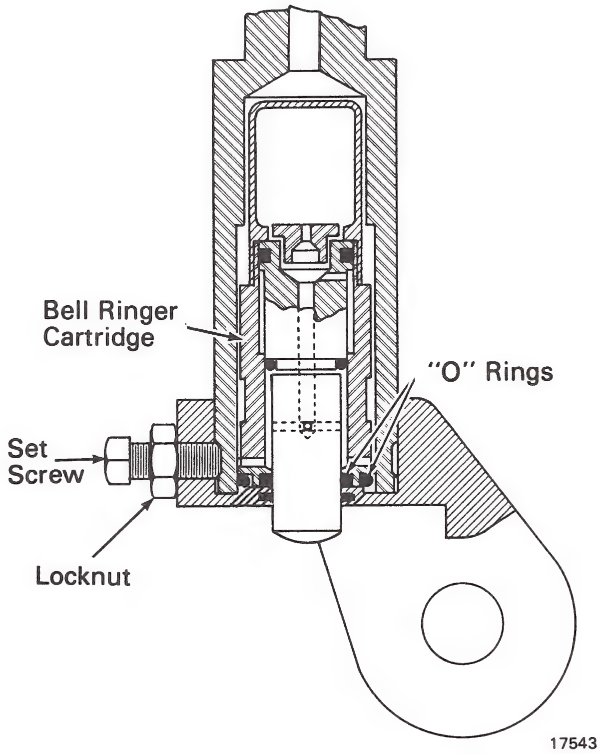

Fig.5-22 – Bell Ringer, Cross-Section

SERVICE DATA

COMPRESSED AIR SYSTEM

REFERENCES

Air Compressor Models WBO And WBG	M.I. 1144
Locomotive Signal Horns	M.I. 2926
Solenoid (Magnet) Valves	M.I. 4707

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

FILTERS

Inlet Compressor Air Filter Element	
(Rectangular Filter)	8347199
(Cylindrical Filter)	8402068
Main Reservoir Air Filter Element	8363343
Air Compressor Lube Oil Filter	8317881

AIR COMPRESSORS

Lube Oil Pressure Gauge	8127030
Intercooler Air Pressure Gauge	8337561

SHUTTER MAGNET VALVE

Replacement Seats	8251091
Replacement Coil	8468748

SPECIFICATIONS

AIR COMPRESSOR

Type	2 Stage
Number Of Cylinders (Basic)	3
Number Of Cylinders (Optional)	6
Displacement At 900 RPM (3 cylinder)	7.2 m^3/Minute (254 Cu. Ft./Min.)
Displacement At 900 RPM (6 cylinder)	11.3 m^3/Minute (400 Cu. Ft./Min.)
Lube Oil Capacity (3 cylinder)	38 Litres (10 Gal.)
Lube Oil Capacity (6 cylinder)	68 Litres (18 Gal.)
Cooling	Water

LUBE OIL

Compressor lube oil must be SAE 10 weight turbine type oil containing anti-rust, anti-oxidation and anti-foam inhibitors. For lubricant properties see M.I. 1756.

DEAD ENGINE PRESSURE REGULATOR SETTING

SD – Single Brake (Composition Shoe)	172 ± 10 kPa (25 ± 1-1/2 psi)
MP, GP – Single Brake (Composition Shoe)	172 ± 10 kPa (25 ± 1-1/2 psi)
MP, GP, & SD – Clasp Brake (Iron Shoe)	172 ± 10 kPa (25 ± 1-1/2 psi)
MP, GP, & SD – Clasp Brake (Composition Shoe)	90 ± 10 kPa (13 ± 1-1/2 psi)

ELECTRICAL EQUIPMENT

INTRODUCTION

The diesel engine drives two electrical generators, which supply electrical energy for locomotive operation. The main generator furnishes power to the motors for locomotive traction. The auxiliary generator supplies low voltage DC power for the control circuits, lights, motor driven pumps, battery charging, and main generator excitation.

In order to control these generators, as well as the circuits and equipment to which they supply power, it is necessary to use electrical devices such as contactors, relays, switches, and regulators. These devices are generally located in the electrical cabinet and the locomotive control stand.

The following provides brief descriptions of electrical components and their functions.

EQUIPMENT DESCRIPTION

MAIN GENERATOR

The D32 main generator, Fig. 6-1, is directly connected to the crankshaft of the diesel engine. It changes mechanical power from the engine to direct current electricity, which is transmitted to the traction motors that drive the locomotive. The generator receives primary excitation from the 74 volt DC output of an auxiliary generator, also driven by the diesel engine.

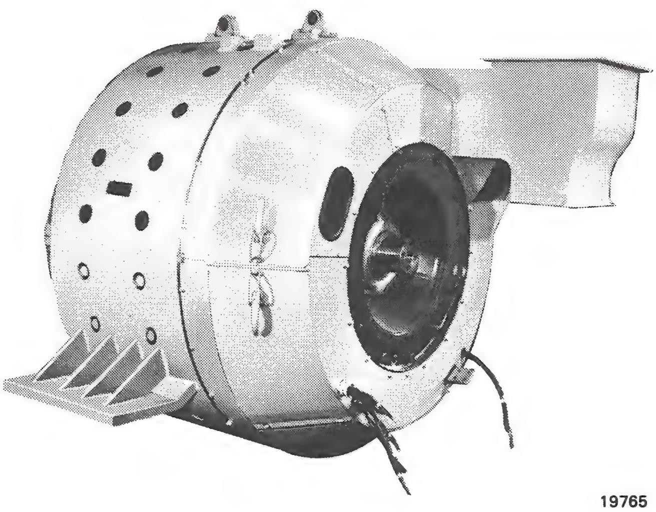

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Fig.6-1 – D32U Main Generator

The level of excitation current is controlled by a static excitation control system and a hydraulically operated load regulator. The load regulator wiper arm position is controlled by the engine governor, through a hydraulically operated vane motor. This system provides for smooth application of power and controls power at a level compatible with engine speed.

TRACTION MOTORS

Electrical power from the main generator is distributed to traction motors, Fig. 6-2, mounted in the trucks. Each motor is geared to a pair of wheels, with the gear ratio selected for the type of service intended. The motors are cooled by means of an external blower that is located in the locomotive unit and is mechanically driven from the engine.

The motor fields and armatures are connected in series to provide the high starting torque required for locomotive service. High motor rotating speeds with reduced back emf are obtained by weakening the motor fields through application of shunting resistors around the fields.

Motor rotation is reversed by reversing the flow of current through the field windings. This is accomplished by switchgear in the locomotive electrical cabinet.

AUXILIARY GENERATOR

Low voltage direct current electricity required during locomotive operation comes from the auxiliary generator, Fig. 6-3. This current is used for excitation of the main generator as well as for energizing control circuits, for battery charging, and for lighting. The auxiliary generator is a self excited machine that uses residual magnetism for initial excitation. A static-type voltage regulator is used in the field excitation circuit of the auxiliary generator

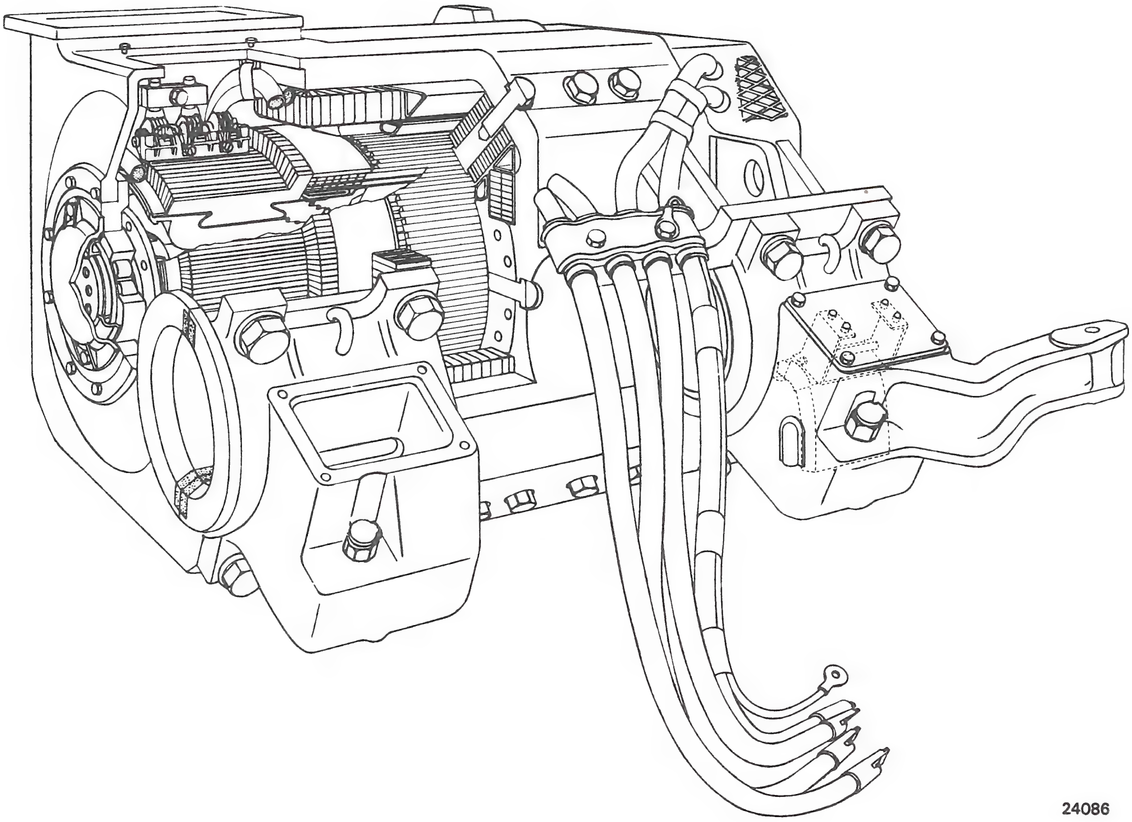
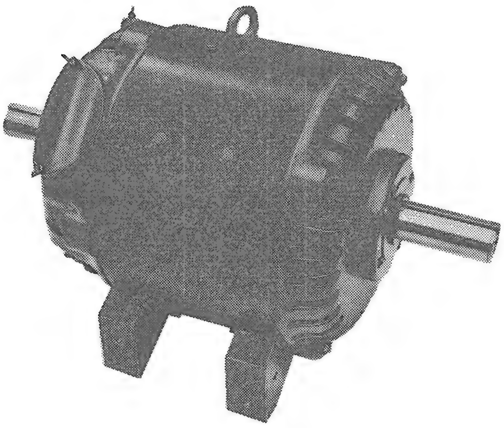
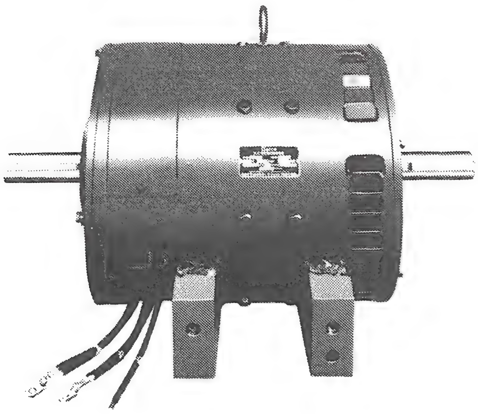


Fig.6-2 – Traction Motor



10kW Generator



18kW Generator

Fig.6-3 – Auxiliary Generator

to hold voltage at a constant 74 volts regardless of load and rotating speed.

LOAD REGULATOR, Fig. 6-4

The load regulator is a plate type rheostat driven by a hydraulically operated vane motor. A pilot valve in the engine governor controls a flow of engine oil under pressure to drive the vane motor clockwise or counterclockwise through a maximum arc of about 300 degrees, thereby positioning the rheostat brush arm and regulating the output of the main generator by varying a signal to a system that controls excitation of the generator field. Control of generator field excitation results in control of the load on the engine. Load control of the engine by the governor permits the governor to maintain engine speed with regulation of power at the correct level for a given speed.

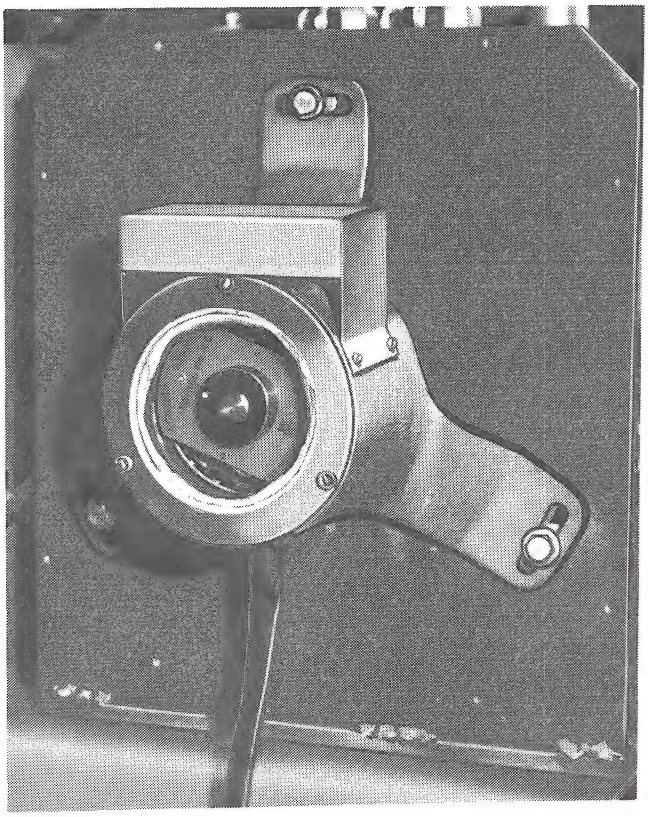


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Fig.6-4 – Load Regulator

FUEL PUMP MOTOR

This is a 0.19 kW (1/4 HP) 1200 RPM 64-74 volt DC motor coupled directly to a fuel pump and mounted on the equipment rack. During engine operation, the pump supplies fuel oil for combustion and injector cooling. More fuel is supplied than is required for combustion. The excess is returned to the fuel tank.

LOCOMOTIVE CONTROL CONSOLE, Fig. 6-5

The locomotive control console contains the switches, gauges, and operating handles used by the operator during operation of the locomotive.

AIR BRAKE EQUIPMENT

The 26NL brake control equipment is located to the left of the controller. This equipment consists of an automatic brake, independent brake, multiple unit valve, cutoff valve, and a trainline air pressure adjustment.

BRAKE VALVE HANDLES

The upper handle controls the automatic or train brakes. The lower handle controls the independent or locomotive brakes.

SWITCH PANEL

The Engine Run, Generator Field, and Control and Fuel Pump switches are located at the right center of the panel. These switches must be on in the controlling unit of a locomotive consist, and must be off in trailing units. Other switches on the panel control various lights and the cab heater.

AIR GAUGE PANEL

Gauges to indicate various pressure concerned with the air brakes are located at the top of the control console. The duplex gauges indicate the following:

1. Main Reservoir – Equalizing Reservoir Pressure.
2. Brake Cylinder – Brake Pipe Pressures.

AMMETER AND INDICATING LIGHTS PANEL

Locomotive pulling force is indicated by the load current indicating meter. The meter is graduated to read amperes of electrical current. It is connected to indicate current through a single motor or through motors in series. Since current is the same in all motors, each motor carries the current shown on the meter.

The PCS OPEN light indicates that the pneumatic control switch has tripped because of an emergency or safety control application of the air brakes.

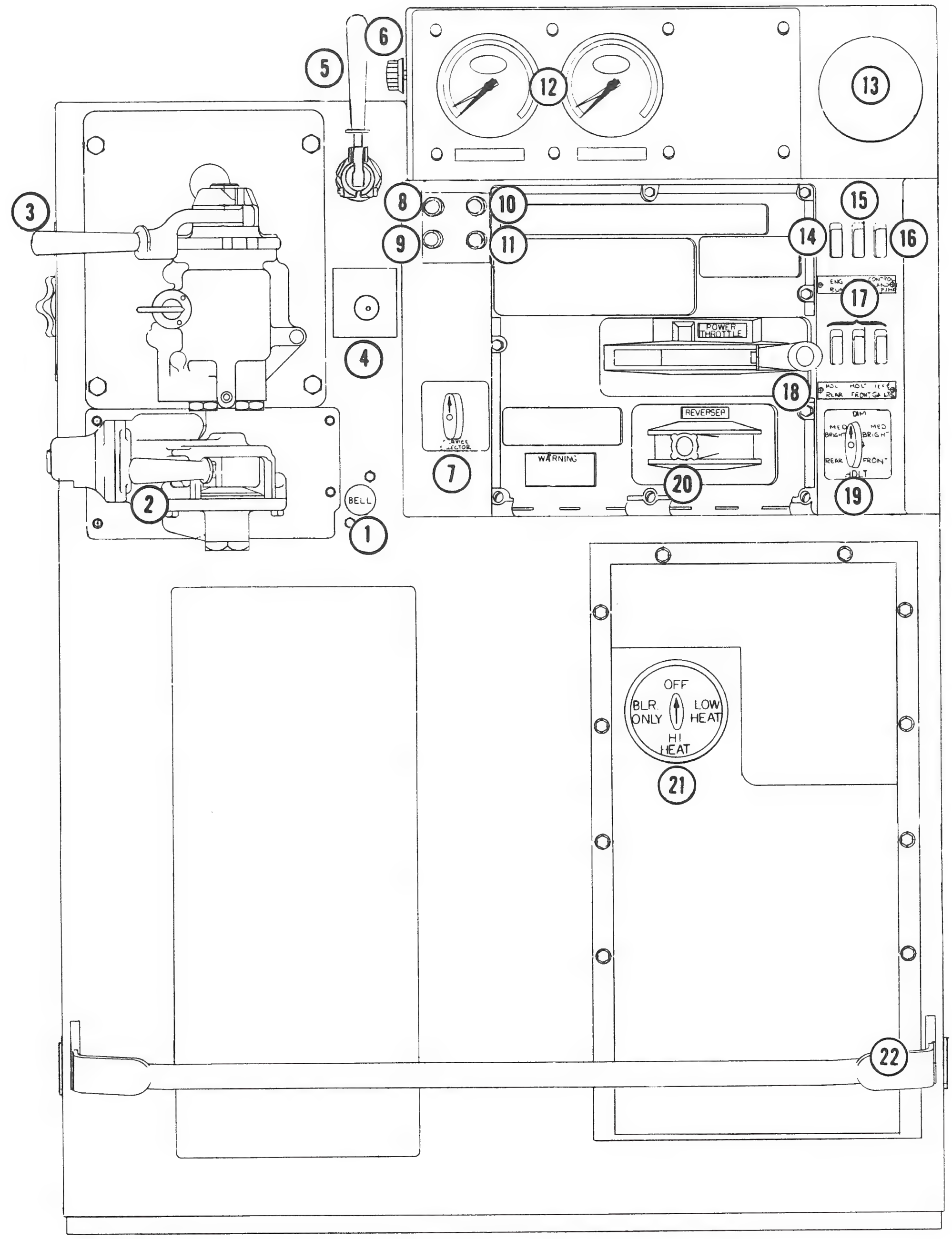
The WHEEL SLIP light indicates that the wheel slip control system is operating to correct slipping wheels.

WARNING

A wheel slip light flashing slowly and persistently may indicate a pair of sliding wheels or circuit difficulty. If such an indication is received, make certain that there are no locked-sliding wheels.

THROTTLE HANDLE

The throttle is the upper handle on the controller panel. It is moved from right to left to increase engine speed and power. The throttle has nine detent positions; IDLE, and 1 through 8 plus a STOP position which is obtained by pulling the handle outward and moving it to the right beyond IDLE to stop all engines in a locomotive consist.



1. Bell Ringer Valve
2. Independent Brake Valve Handle
3. Automatic Brake Valve Handle
4. Sanding Switch(es) (When Equipped)
5. Air Horn Valve Handle
6. Rheostat
7. Service Selector Switch
8. PCS Open Light
9. Wheel Slip Light
10. Signal Light
11. Sanding Light
12. Air Brake Gauges
13. Load Current Indicator
14. Engine Run Switch
15. Generator Field Switch
16. Control And Fuel Pump Switch
17. Miscellaneous Light Switches
18. Throttle
19. Headlight Dimming Switch
20. Reverser Handle
21. Heater Fan Switch
22. Safety Control Foot Bar

24818

Fig.6-5 – Typical Locomotive Control Console

REVERSER HANDLE

The reverser handle is the lowest handle on the controller panel. It has three detent positions: left, centered, and right. When the handle is moved to the right toward the short hood end of the locomotive, circuits are set up for the locomotive to move in that direction. When the handle is moved to the left, toward the long hood end of the locomotive, circuits are set up for movement in that direction. With the reverser handle centered, operation of the throttle handle will not apply power to the locomotive. The reverser handle is centered and removed from the panel to lock the throttle in IDLE.

SANDING SWITCH

A non-latching, non-directional wobble stick actuates an electrical switch to initiate sanding. The position of the reverser handle sets up the proper sanding valves at the leading wheels of each locomotive unit in tandem.

SAFETY CONTROL PEDAL

When the safety control pedal is released, a service application of the brakes will occur after a time delay unless there is a specific pressure in the brake cylinders. During the time delay, a whistle will sound to alert the operator that a safety control brake application will occur unless the pedal is pressed or brakes applied.

FUSE AND SWITCH PANEL, Fig. 6-6

The fuse and switch panel is located behind a panel at the back of the control console and contains the following fuses and switches.

FUSE TEST EQUIPMENT

A fuse test block and test lamp are provided along with a test lamp switch. All fuses should be tested before they are installed.

GROUND RELAY CUTOUT SWITCH

The purpose of the ground relay cutout switch is to disconnect the ground protective relay from locomotive circuits during certain shop maintenance inspections. The switch should be closed during operation.

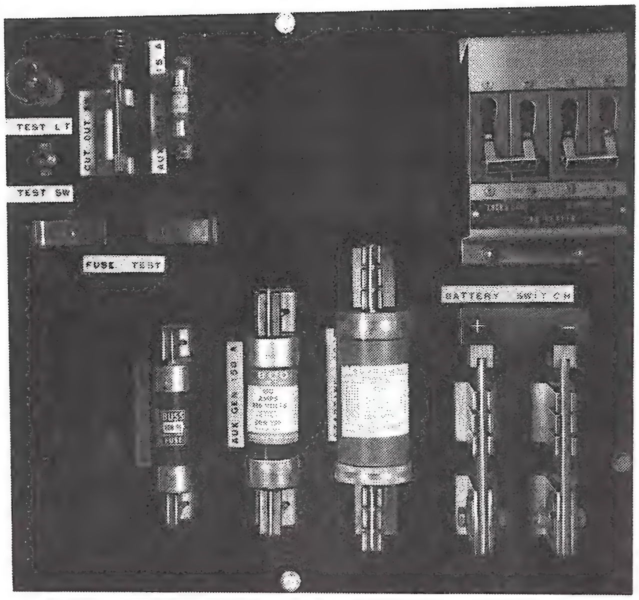


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Fig.6-6 – Typical Fuse And Switch Panel

AUXILIARY GENERATOR FIELD FUSE (15 Amperes)

The field excitation circuit of the auxiliary generator is protected by a 15 ampere fuse. This fuse must be good and in place at all times during locomotive operation. If the fuse opens there will be no auxiliary generator output to the low voltage control system and the fuel pump will stop. The engine will eventually stop from lack of fuel.

CAB HEATER CIRCUIT BREAKERS

Electrical power to the cab heaters is provided through these circuit breakers.

BATTERY FIELD FUSE (80 Amperes)

The battery field windings of the main generator are excited by current from the low voltage system through the BF contactor. This fuse protects circuit supplying battery power to the battery field controlled rectifier SCR for main generator battery field excitation.

AUXILIARY GENERATOR FUSE (150 Amperes)

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. If the fuse opens, no auxiliary generator output is provided to the low voltage system and the fuel pump will stop. The engine will eventually stop from lack of fuel.

STARTING FUSE (400 Amperes)

The starting fuse is in use only during the period of engine cranking. At this time, battery current flows through the fuse and starting contactor to the main generator starting field.

MAIN BATTERY KNIFE SWITCH

This switch connects the battery to the locomotive low voltage system. The switch must be closed during locomotive operation. It may be opened during shop inspections and during locomotive layover.

CIRCUIT BREAKER PANEL, Fig. 6-7

The circuit breaker panel is located behind panels at the back side of the control console. The circuit breaker panel contains the traction motor cutout switch and various circuit breakers which provide protection for various electrical circuits.

TYPICAL SWITCHGEAR PANEL AND CONTROL PANEL ARRANGEMENT, Fig. 6-8

The switchgear panel and the control panel are mounted on an "L" frame. The switchgear panel is mounted under the cab floor opposite the operator's station and is accessible from outside the locomotive. The control panel extends above the cab floor and forms part of the forward portion of the cab wall.

RE-FS12, RE-FS34; MOTOR FIELD SHUNTING RESISTORS (When Provided), Fig. 6-8

During locomotive operation these resistors are connected in parallel with the traction motor fields to reduce back emf from the motors and allow full use of power from the main generator.

E1-E2 AND RE-SF

These resistors are connected in series with the main generator shunt field to obtain the desired shunt field characteristics.

BATTERY CHARGING RESISTOR RE-BC

This limiting resistor protects the auxiliary generator and battery charging circuit against high current in the event that the battery has a very low charge. This resistor is located behind the field shunting resistors REFS-12 and REFS-34, Fig. 6-8.

SWITCHGEAR PANEL, Figs 6-8 And 6-9

The switchgear panel contains most of the heavy duty high voltage components such as the power contactors, reverser switches, field shuting contactors, equipment bus, and load indicating meter shunt. A resistor panel and the battery charging rectifier is also mounted on the switchgear panel.

BATTERY CHARGING RECTIFIER, CR-BC

The battery charging rectifier, Fig. 6-9, consists of rectifier CR-BC and resistor RE-BC. The rectifier consists of a pair of heat sink mounted silicon diodes in parallel with a suppression rectifier that protects the silicon diodes from voltage spikes. CR-BC blocks battery current from generator windings and from cab heater elements when the diesel engine is stopped.

CR31;

This rectifier, in series with a fixed resistance, is connected across the main generator battery field to control the decay rate of the field.

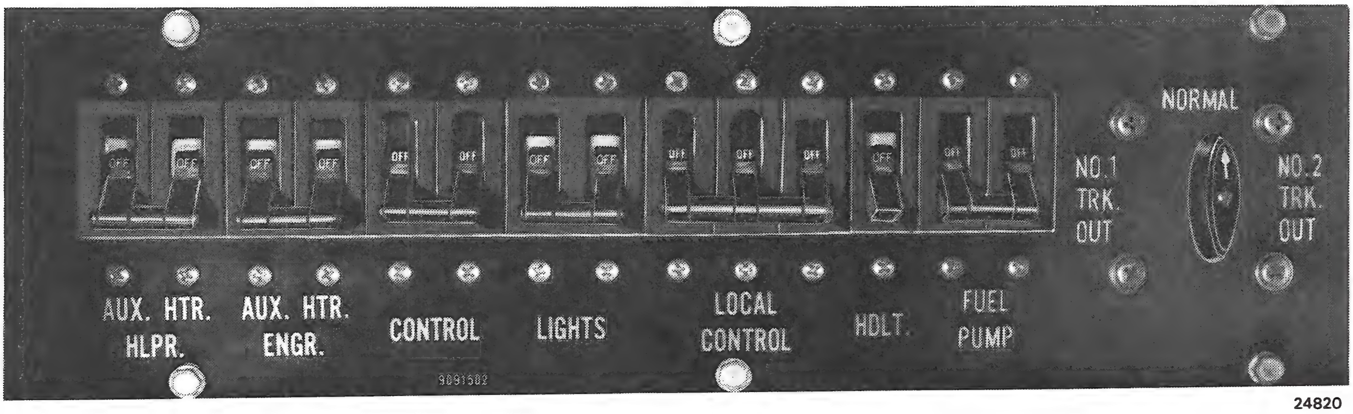

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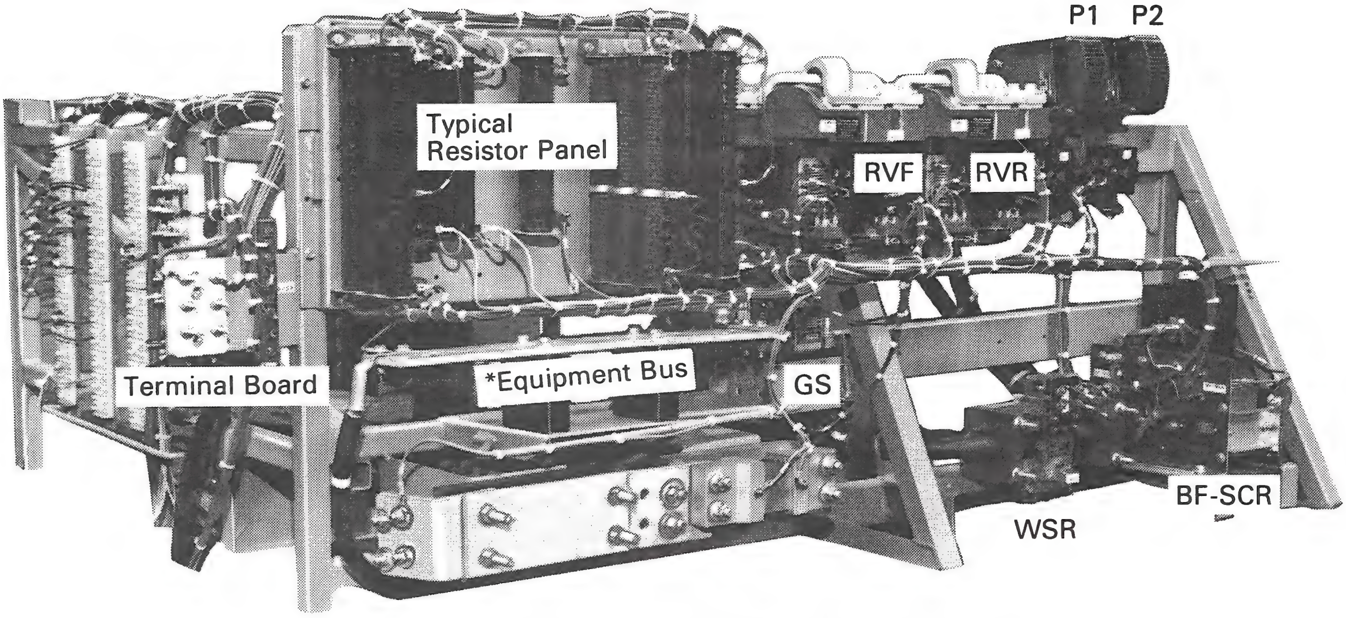
Fig.6-7 – Typical Circuit Breaker Panel



*On Units Equipped With FS Module, Motor Field
Shunt Is Applied.

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Fig.6-8 – Typical Switchgear Panel And Control Panel Arrangement

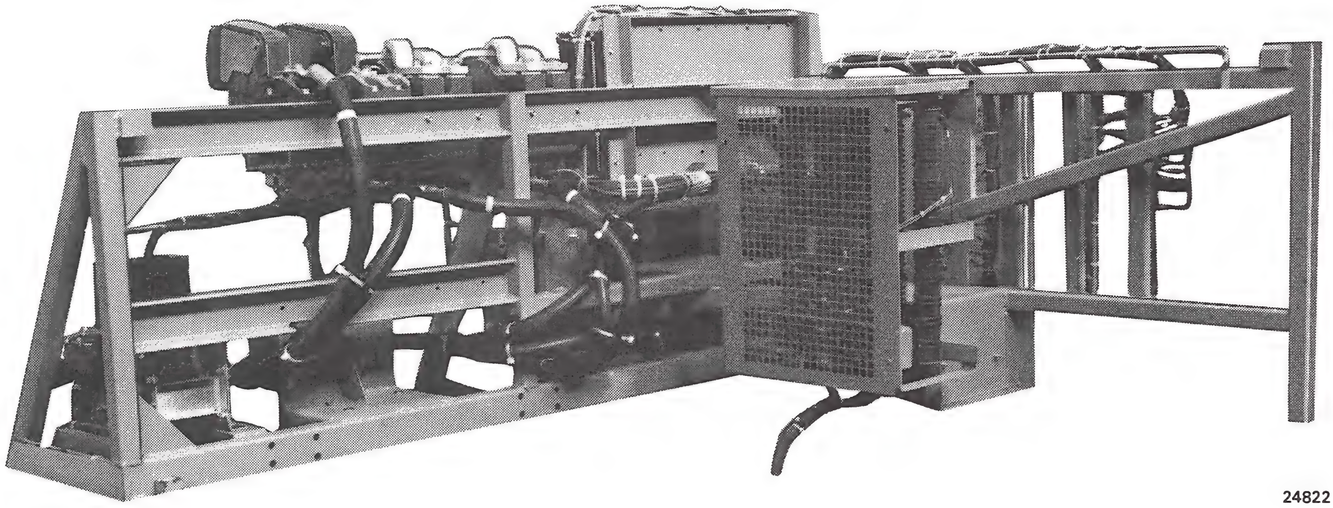

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Fig.6-9 – Typical Switchgear Panel – Rear View

FS1; FIELD SHUNTING CONTACTOR (When Provided)

When energized, this contactor connects field shunting resistors in parallel with the traction motor fields. The resulting decrease in back emf extends the full horsepower speed range.

FS CIRCUIT MODULE (When Provided)

FIELD SHUNTING

Field shunting is required in order to stay within current limitations of the main generator at low track speed and within voltage limitations at high

speed. This is accomplished by utilizing full strength traction motor field at low speed and connecting a low resistance shunt across the traction motor fields to divert a portion of the motor current around the fields at high track speed.

Field shunting is initiated by the FS module. The FS module contains a magsense amplifier, calibrating resistors, relays, and transistors with associated circuitry. Voltage and current signals are provided from the main generator shunt to the magsense amplifier. The calibrated current signal is larger than the calibrated voltage signal at lower track speed. The field shunting pilot relay on the FS module picks up to initiate field shunting whenever the calibrated voltage signal rises above the calibrated current signal. The voltage signal increases and the current signal decreases as track speed increases.

GS; GENERATOR (ENGINE) STARTING CONTACTOR

When the Fuel Prime/Engine Start switch is placed in the ENGINE START position, the GS contactor closes to provide battery power to the starting windings of the main generator. Interlocks of GS ensure dropout of all power contactors during engine cranking.

EQUIPMENT BUS

This bus should be removed to isolate the traction motors from the main generator when performing load test.

LOAD INDICATING METER SHUNT

The load indicating meter shunt provides a millivolt signal, proportional to main generator current, to the load indicating meter.

MAIN GENERATOR SHUNT PANEL BUS

The main generator shunt panel bus is removed during load testing. This provides a means of isolating the traction motors from the main generator during load test.

MOTOR FIELD SHUNT

Voltage and current signals for motor field shunting control are obtained from this shunt.

P1, P2; POWER CONTACTORS, Fig.6-10

These electro-magnetic contactors are energized and closed to connect the traction motors in series-parallel with the main generator. Auxiliary contacts of these contactors perform various functions in the control circuits.

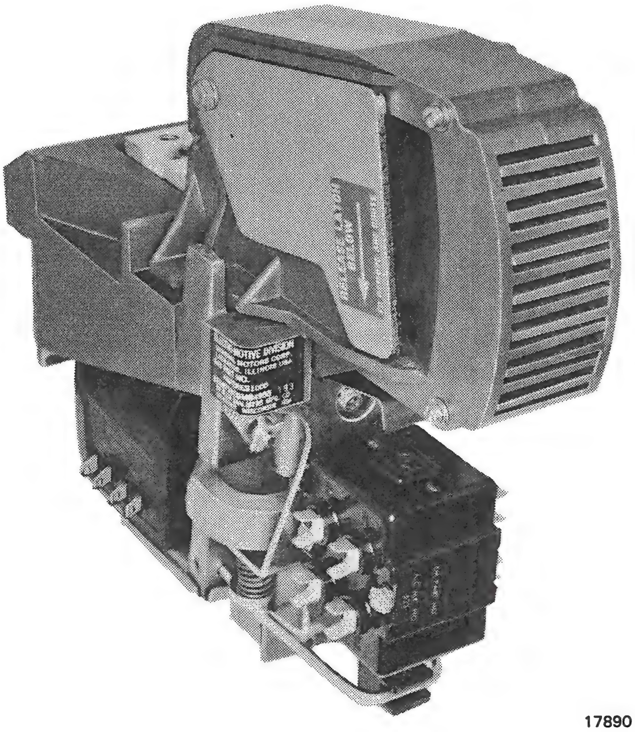

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Fig.6-10 - Power Contactor

RE50

This resistor provides proper voltage for the Controller Indicating Lights.

RESISTOR PANEL ASSEMBLY, Fig. 6-11

RE3A, RE3B

These resistors are used in the wheel slip bridge circuits.

RE4A, RE4B

These resistors are used in the wheel slip bridge circuits.

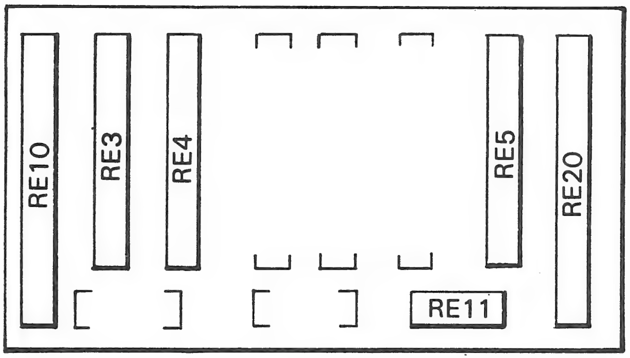

Fig.6-11 – Typical Resistor Panel Assembly

RE5 (When Applicable)

This resistor is connected in series with the hump control rheostat.

RE10A-B, RE20A-B

These resistors provide proper voltage for the headlights.

RE11

Provides battery field reference signal to hump control system.

RE-GA1, RE-GA2, RE-GA3

Gage lights resistors.

RVF; RVR REVERSER SWITCHGEAR

These electro-magnetic switches control the direction of current flow through the traction motor fields and thus control their direction of rotation. The forward reversing switch RVF is energized when the reverse lever on the locomotive controller is placed in the forward position. RVF is energized by local control power through action of the forward relay FOR. RVR is energized by local control power through action of the reverse relay RER when the reverse lever on the locomotive controller is placed in the reverse position.

WCR, WHEEL CREEP RELAY (When Applicable)

This through-cable relay is provided on units using the two-stage wheel slip correction system. Operation of this relay as the first stage of wheel slip correction results in a timed application of sand to the rail, but does not cause a reduction in power or cause the wheel slip light to come on. If the wheel slip persists, the WSR through-cable relay operates to drop the battery field and light the wheel slip light.

WSR, WHEEL SLIP RELAY

This through-cable relay operates to drop the battery field and provide a feed to the wheel slip light whenever a wheel slip of sufficient magnitude is detected. The WSR relay operates at a higher differential current than the WCR relay.

MAIN CONTROL PANEL, Figs. 6-8 And 6-12

AVC, BVC, CVC; THROTTLE RESPONSE CONTACTORS

As throttle position is changed, these contactors are energized separately or in combination along with corresponding solenoids in the engine governor. The contactors control resistance in series with the main generator battery field. The corresponding solenoids control engine speed. Locomotive power is thereby precisely controlled by throttle position.

BF; MAIN GENERATOR BATTERY FIELD CONTACTOR

Pickup of BF provides a path for excitation current to the main generator battery field. The BF contactor picks up when the throttle is advanced out of idle position. BF drops out during ground relay operation, wheel slip action, and when the throttle is returned to idle position.

Auxiliary contacts of BF are used to provide a feed to the overriding solenoid ORS, which drives the load regulator toward minimum field position, when BF drops out.

DVR; ENGINE SHUTDOWN RELAY

The governor CV solenoid is energized when operating in SWITCHING 2 mode. Placing the throttle to STOP provides a feed to DVR and to the governor DV solenoid. Pickup of DVR drops the feed to the CV solenoid. This permits stopping all units in a consist when the throttle is set to STOP.

ER; ENGINE RUN RELAY

The function of ER is to set up control circuits to governor speed setting solenoids. The diesel engine will not run above idle speed until ER picks up.

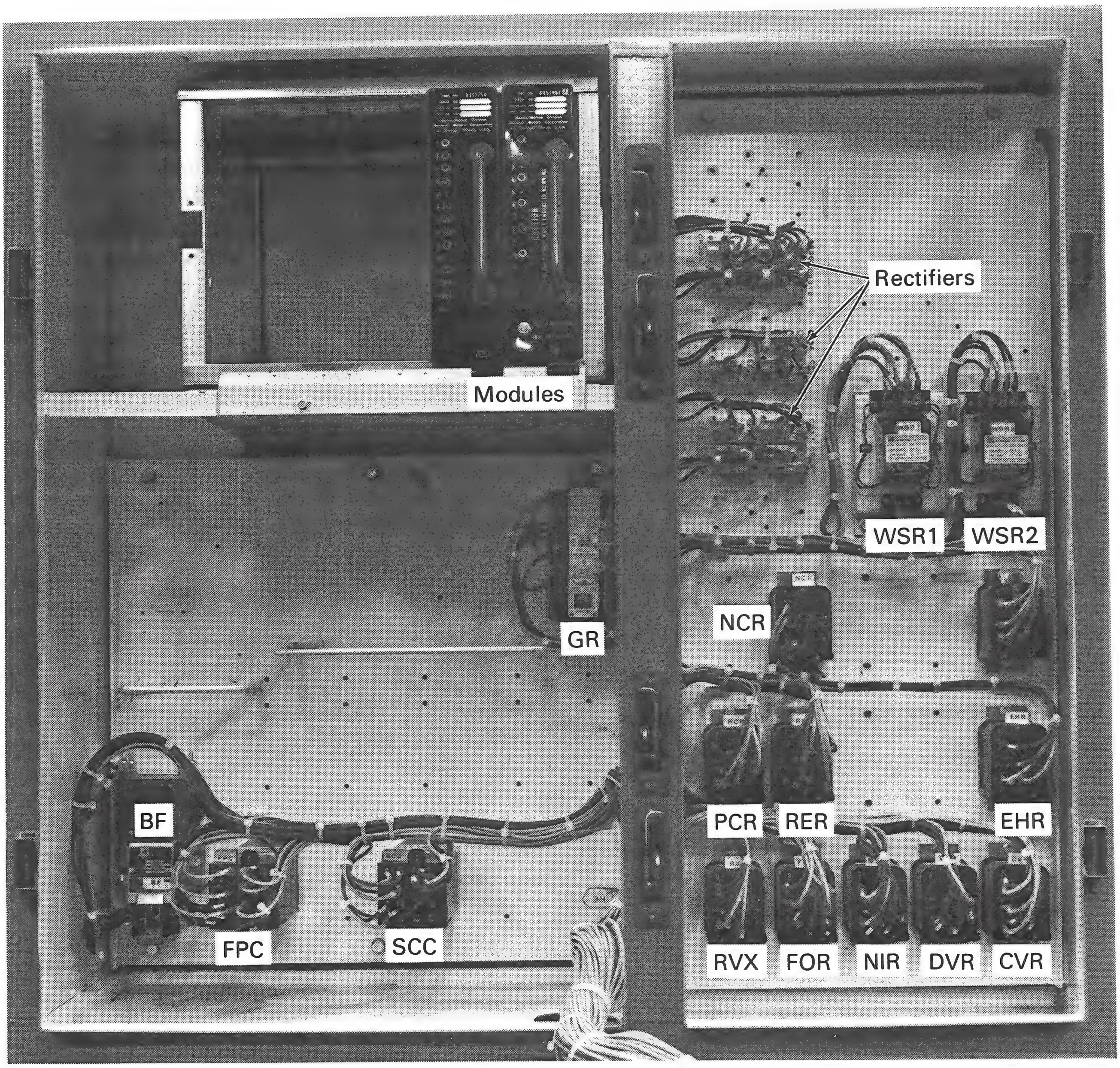

Fig.6-12 – Main Control Panel

FOR, RER; FORWARD AND REVERSE RELAYS

These relays control the direction in which the locomotive moves. The relays are energized by trainlined control current when the reversing lever is placed in the appropriate position. Contacts of the relays make or break circuits to actuate heavy duty electro-magnetic switchgear. The switchgear establishes the direction of high voltage main generator current flow through the traction motor fields.

Crossover wires at each of the jumper cable receptacles between units of a locomotive consist are so arranged that whatever the makeup of the consist, the appropriate relays in trailing units will be energized.

FPC; FUEL PUMP CONTACTOR

The purpose of the fuel pump contactor is to bring about shutdown of the diesel engine when EFCO1, EFCO2, or EFCO/STOP pushbutton is pressed. Dropout of FPC accomplishes shutdown by

dropping out the ER relay which breaks the circuits to the governor speed setting solenoids and by independently energizing the governor shutdown solenoid DV.

FPR; FUEL PUMP RELAY

The primary purpose of the fuel pump relay is to provide the locomotive operator with the means of shutting off the fuel pump from a switch on the control stand. Before the engine is running, the relay performs no function, but it must be picked up to set up the fuel pump motor circuit.

CAUTION

The control and fuel pump switch must always remain in the ON position while the engine is running. If an engine shuts down from lack of fuel, damage to the engine injectors is possible.

FSD; FIELD SHUNT DELAY RELAY

The FSD relay is energized when locomotive speed results in pickup of field shunting relay FSR1.

Immediate response contacts of FSD act to drive the load regulator toward minimum field position. After a short time delay, timed contacts of FSD provides a feed to field shunting contactor FS1, and a second set of timed contacts of FSD open the feed to ORS which allows the load regulator to move to a balanced position after FS1 picks up.

GFR; GENERATOR FIELD RELAY

This relay is dropped when throttle is at idle and picked up when throttle is advanced. GFR functions to prevent engine shutdown during ground relay action with throttle in No. 5 or No. 6 position.

GR; GROUND RELAY

The ground relay detects low voltage grounds during engine starting and high voltage grounds during operation. When the relay picks up, generator excitation is lost and the diesel engine is restricted to idle speed. An indicating light on the engine control panel lights and an alarm bell sounds when GR picks up. The relay is held in its tripped position by a mechanical latch and must be reset by pressing the ground relay reset pushbutton before operation can continue.

HUMP SPEED CONTROL SYSTEM

The hump speed control system controls the position of the load regulator, thereby controlling excitation to the main generator. Locomotive power can be reduced by reducing the throttle setting. However, reducing power in smaller increments better suits the operating conditions preculiar to humping service. Reducing the excitation as the load lessens makes possible a fine balance between power output and power required.

When the hump control switch on the controller is set to ON, the RHA relay provides a feed to the hump control light and to the HR relay in each unit of the consist. The RHA relay also connects the controlling unit HCR relay between load regulator output and the hump control rheostat wiper arm. Pickup of the HR relay disconnects the load regulator paralleling resistors in each unit of the consist to provide a larger range for control of the excitation signal from the load regulator. Pickup of HR also connects HCR of trailing units between the hump control rheostat and output of the load regulators in the trailing units. The hump control relay HCR compares the hump control signal from the hump control rheostat with output of the load regulators. HCR operates to provide a feed to ORS when output of the load regulator rises above the hump control signal. This action results in maintaining the load regulator output within 0.5 volt of the hump control signal. Therefore, the load regulator excitation signal can be closely controlled by the hump control rheostat.

SCC; SWITCHING CONTROL CONTACTOR

This contactor is energized only when the service selector switch is set to SWITCHING 1 or SWITCHING 2 mode. When energized, SCC opens the feed to ORS which allows the load regulator to move to maximum field position at locomotive start for switching operation.

TDS; TIME DELAY SAND RELAY (When Provided)

This relay is energized by operation of the wheel creep relay WCR on units so equipped. When energized, TDS provides a timed application of sand to the rails.

WSR1, WSR2; WHEEL SLIP RELAYS

These relays are used in the wheel slip bridge circuit. These relays operate to drop out the main generator battery field contactor and to provide a feed to the wheel slip light when a wheel slip is detected.

ENGINE CONTROL PANEL, Fig. 6-13

The following paragraphs provide a brief functional description of the various switches and warning lights located on the engine control panel.

EMERGENCY FUEL CUTOFF & ENGINE STOP PUSHBUTTON

Momentarily pressing this pushbutton results in immediate engine shutdown.

GROUND RESET PUSHBUTTON

After pickup, the ground protective relay is held in the operated position by a mechanical latch. The mechanical latch releases when the ground reset pushbutton is pressed.

GR'D REL TRIPPED Light

This light comes on when the ground relay operates.

GOVERNOR SHUTDOWN Light

Accompanied by engine shutdown for one of the following reasons:

1. Excessively hot lube oil.

   This type of shutdown will normally be preceded by a hot engine light indication. No other indication is given except an extremely hot condition of the engine and cooling system. Do not attempt to restart the engine until it has been allowed to cool down and an engine inspection has been made by qualified personnel.

2. Low engine oil pressure.

   Low oil level, or failure of the lube oil pump may bring about this type of shutdown. The low oil plunger on the engine governor will protrude, with no other fault indication given.

3. Low water level or low pressure at the water pumps.

   A detector at the engine accessory drive gear housing senses low water pressure and actuates the low oil shutdown mechanism. The low water detector reset button will protrude along with the governor low oil pressure plunger.

4. Crankcase (oil pan) overpressure due to an engine fault.

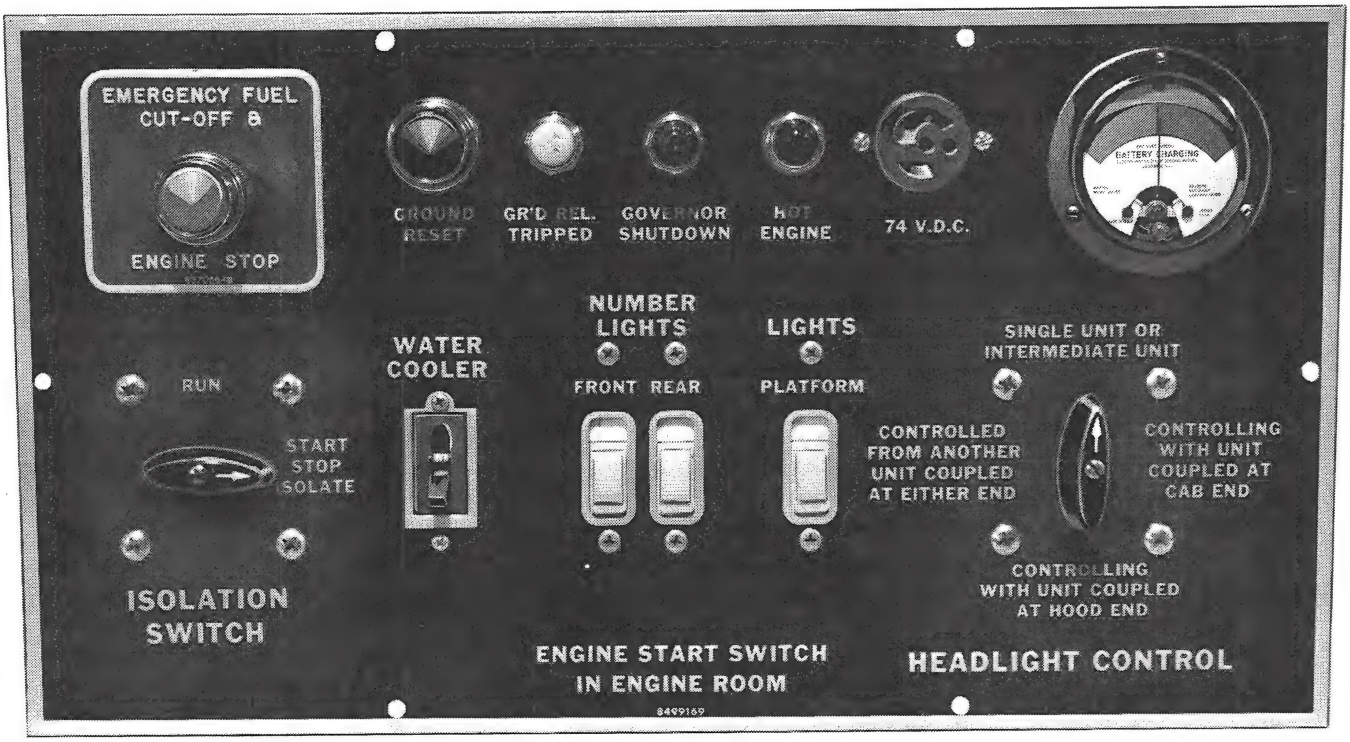

Fig.6-13 – Typical Engine Control

Pressure in the crankcase (oil pan) will trip the crankcase overpressure detector and bring about a low oil pressure shutdown. The reset button will protrude along with the governor low oil pressure plunger. Overpressure may be caused by a crankcase explosion, or by a fault allowing cylinder or airbox pressure into the oil pan.

WARNING

When a crankcase overpressure trip indication is observed, leave the engineroom area. Allow a 2 hour cooldown period before making further inspections or taking corrective action.

HOT ENG Light

This light comes on when excessive temperature results in operation of the engine temperature switch ETS.

BATTERY CHARGING INDICATOR

This indicator indicates storage battery charge or discharge. The needle should be at zero or to the right of zero when the engine is running.

ISOLATION SWITCH

This two position switch allows any unit in a locomotive consist to be "taken off the line" regardless of control signals from the controlling unit.

START/STOP/ISOLATE Position

The switch must be in this position to start the engine. The unit will not develop power when the switch is in this position. However, if the controlling unit of a multiple unit consist is isolated, all trailing units will respond to the controls of the controlling unit.

The isolation switch should be placed in this position before stopping the engine, but switch position does not negate any engine stopping switch or device.

RUN Position

The isolation switch must be in the run position in order for the unit to respond to controls and develop power. The alarm bell will sound if the engine is shut down with the isolation switch in the run position.

HEADLIGHT CONTROL SWITCH

Power for the front and rear headlight is provided by the lead unit in a locomotive consist. This switch sets up the circuits for control of the front and rear lights from the lead unit and through any intermediate units. The switch must be properly positioned in each unit of the consist.

MISCELLANEOUS SWITCHES

Switches are provided for various lights employed on the locomotive. A water cooler switch may be provided.

ENGINE ACCESSORY CONTROL CABINET, Fig. 6-14

The engine accessory control cabinet is located on the equipment rack in the engineroom. It contains relays used for control of air compressor loading and unloading and for control of automatic air filter strainer drains.

CCR, CRL; COMPRESSOR RELAYS

On units equipped with synchronization of all compressors in a consist, the compressor relays in all units of the consist are energized when the main air reservoir pressure in any unit falls below a preset level. The compressor relays in the individual units will remain energized until all reservoir pressures build up to the normal level.

CCS; COMPRESSOR CONTROL SWITCH

The compressor control switch senses main reservoir pressure. It trips to energize the compressor relay in all units of a consist when main reservoir in any one unit falls below the desired pressure.

On special order a second sensing device can be included in the compressor control switch. This device will de-energize the compressor relay in any individual unit if main reservoir pressure in that unit approaches the safety valve setting of that unit.

An additional function of the compressor control switch is the pickup (through compressor relay CR contacts) of magnet valves at main and auxiliary strainer drains. The strainer drains will blow free for a moment whenever the magnet valves are energized or de-energized.

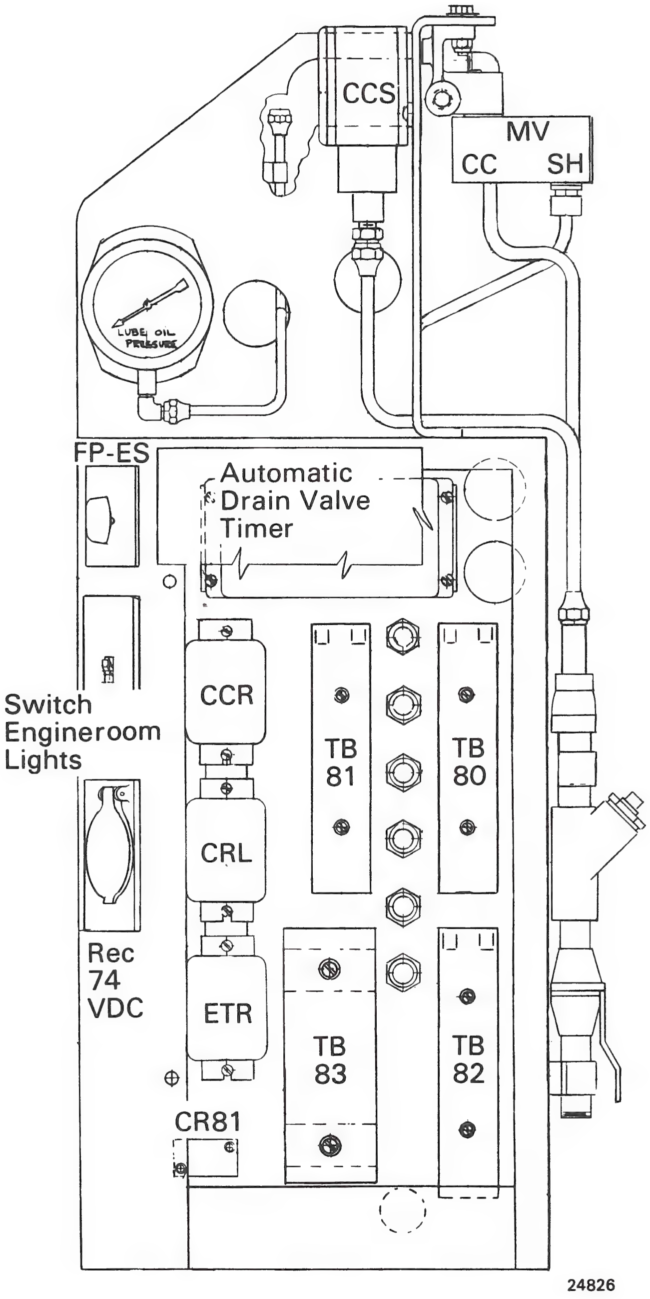

Fig.6-14 – Typical Engine Accessory Control Cabinet

ETR, ENGINE TEMPERATURE RELAY

This relay is energized by operation of the engine temperature switch ETS. Pickup of ETR drops the feed to the shutter magnet valve MV-SH. Removing the feed from MV-SH allows the shutters to open. Therefore, ETR is used as backup protection in case the shutter temperature switch fails to operate properly.

MV-CC COMPRESSOR CONTROL MAGNET VALVE

This valve is located at the engine accessory control cabinet on the equipment rack. When the valve is de-energized, the air compressor unloader valve opens and the compressor beings to pump. The magnet valve is de-energized when the compressor control switch senses low main reservoir pressure.

MV-SH; SHUTTER CONTROL MAGNET VALVE

The shutter control magnet valve is energized through normally closed contacts of the shutter temperature switch STS. When energized, MV-SH opens to supply compressed air to the shutter operating piston. The piston drives the shutters closed. When STS picks up MV-SH is de-energized. The compressed air supply is stopped and the shutter operating cylinder is vented. Spring pressure at the piston drives the shutters open.

AUTOMATIC DRAIN VALVE TIMER

This device is applied on special order to time the operation of the automatic drain valves in the compressed air system of the locomotive. With the system, automatic drain valve blowdown occurs at timed intervals.

GUIDE TO THE EXCITATION AND POWER CONTROL SYSTEM

CAUTION

The data appearing in this section is intended only as a guide in explaining the locomotive excitation and power control system. The circuits shown in this section represent typical components and do not necessarily agree with the wiring diagrams of specific locomotives. Consult the applicable locomotive wiring diagrams and the troubleshooting section of this manual when performing troubleshooting on the excitation and power control system.

INTRODUCTION

The purpose of this section is to describe the locomotive excitation and power control system. A block diagram of the excitation and power control system is provided in Fig. 7-1.

The excitation and power control system is designed for high reliability and minimum down time. Minimum down time is assured by using top quality components and some plug-in modules. The modules are centrally located in the electrical cabinet on the cab side. Each module contains components that are functionally related. For example, the excitation control (EC) module contains components that control excitation.

The modules are provided with test jacks for making voltage measurements when performing trouble-shooting. The excitation control module is equipped with a test switch for performing functional checks on the module. The modules are designed to be adjusted on the test bench in the shop. Therefore, when a module is changed out it is not necessary to adjust the module while installed on the locomotive. This feature greatly reduces locomotive down time.

GENERAL

When the diesel engine starts to turn, the DC auxiliary generator is initially self excited by residual magnetism. As engine speed increases, generated voltage builds up and part of the auxiliary generator output is fed back through the static voltage regulator. Output from the voltage regulator is used to control excitation to the auxiliary generator and maintain constant voltage.

Part of the auxiliary generator output is provided to the battery field silicon controlled rectifier assembly BF-SCR to excite the main generator battery field. Output from the BF-SCR is determined by the excitation control module EC1 which responds to signals related to main generator output, throttle position, and load regulator position. Output from the main generator is applied to the traction motors.

CONTENTS

This section is divided into the following parts:

Part A - Generators and Voltage Regulator

Description of the auxiliary generator, voltage regulator, and D32 main generator.

The contents of Section 7 Part A are presented in the following order:

1. AG – Auxiliary Generator
2. D32 – Main Generator And Ground Relay Protection System
3. VR – Voltage Regulator Module, VR10
4. VR – Voltage Regulator Module, VR11 (Special Order)

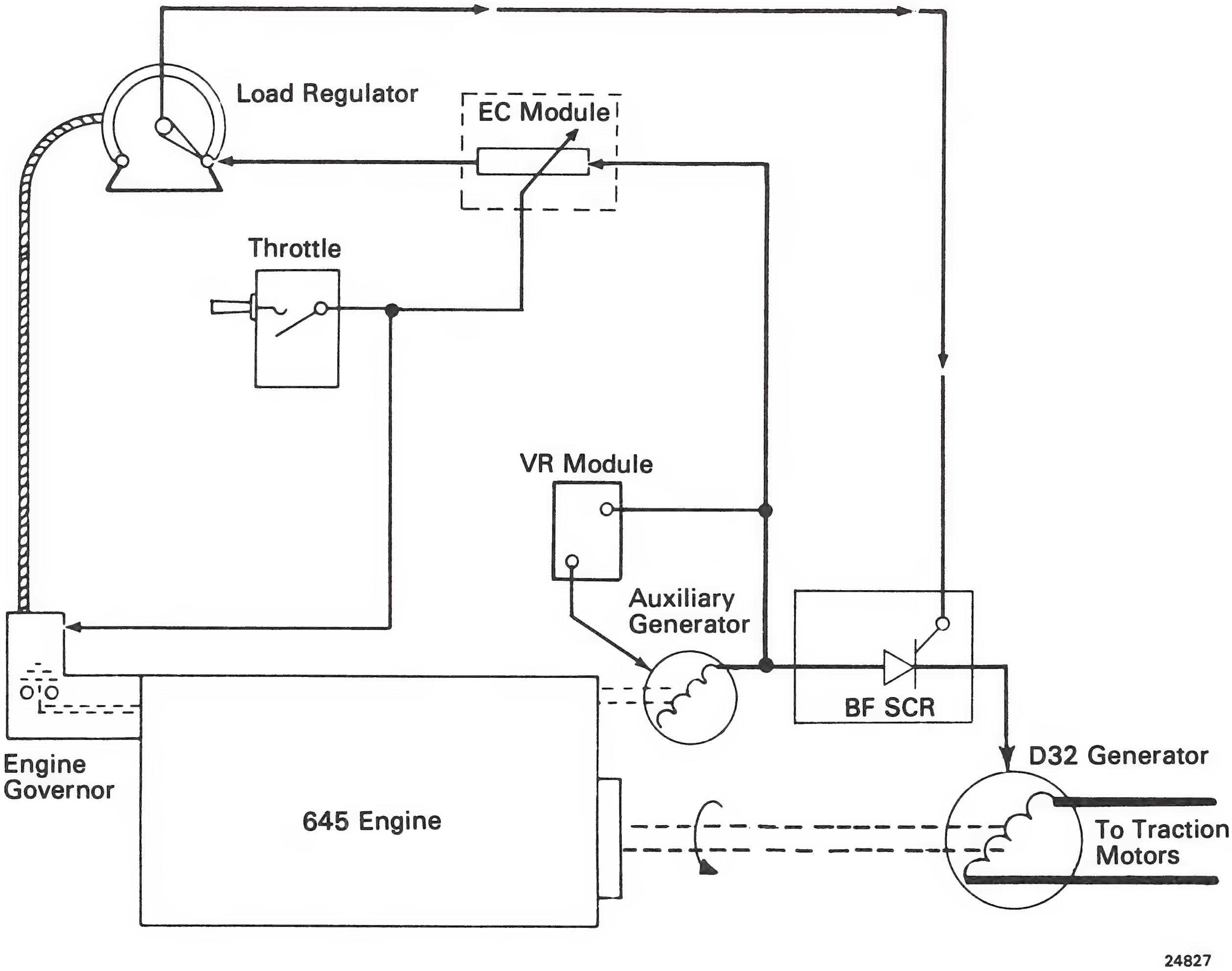

Fig.7-1 – Excitation System Block Diagram

Part B – Excitation and Power Control System

General description of the excitation and power control system and a detailed description of each module or assembly used in the excitation and power control system.

The contents of Section 7 Part B are presented in the following order:

1. BF-SCR – Battery Field, Silicon Controlled Rectifier
2. EC – Excitation Control Module
3. FS – Field Shunting Control System
4. LR – Load Regulator Assembly

Part C – Wheel Slip Detection and Correction System

General description of the wheel slip detection and correction system and detailed description of each assembly used in the wheel slip detection and correction system.

AUXILIARY GENERATOR

The auxiliary generator is a variable speed, self excited, shunt wound, direct current generator with an output of 10 kilowatts, Fig. AG-1. An 18 or 24 kW auxiliary generator, Fig. AG-2, is available on special order. A solid state voltage regulator is used to regulate the output voltage at 74 volts nominal at generator speeds of 825 to 3,000 RPM.

The auxiliary generator is driven by the diesel engine through a flexible coupling and provides direct current power for lighting circuits, control circuits, main generator excitation, charging storage batteries, and other miscellaneous low voltage direct current requirements. The auxiliary generator rotates at a speed approximately three times as fast as the diesel engine.

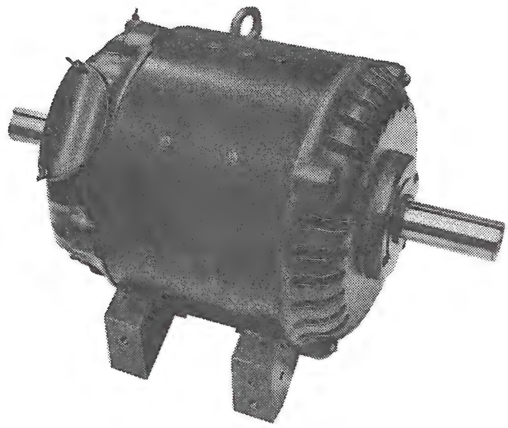

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Fig.AG-1 – 10 kW Auxiliary Generator

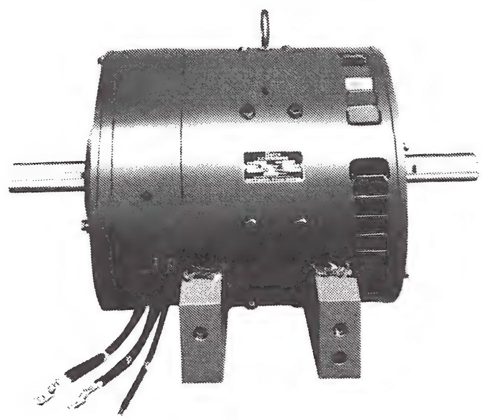

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Fig.AG-2 – 18 or 24 kW Auxiliary Generator

ELECTRO-MOTIVE

LOCOMOTIVE SERVICE MANUAL

D32 MAIN GENERATOR

INTRODUCTION

The D32 generator is used as an electrical motor to crank the diesel engine during starting and as a generator to provide power to the traction motors during normal operation. The four traction motors are connected in permanent series-parallel across the main generator output. However, motor field shunting is available upon request from the customer.

The generator contains six fields. A brief description of each field is provided in the following paragraphs. A simplified schematic diagram of the generator is provided in Fig. D32-1.

STARTING FIELD

The starting field is connected in series with the armature and contains a few turns of heavy conductor. This field is energized from the battery and is used only during engine start.

BATTERY FIELD

This field contains a few turns of heavy conductor and is excited from the battery during locomotive operation. Excitation to this field is controlled by the excitation control system consisting of the excitation control module EC, the battery field silicon controlled rectifier BF-SCR, and the load regulator. The excitation control system is under command of the throttle and the engine speed governor.

SHUNT FIELD

The shunt field contains many turns of small wire and is connected to the generator output terminals. This field aids the battery field, but has very little effect at low speeds due to low generator output voltage and relatively high resistance of the shunt field. However, the effect of the shunt field increases as main generator output voltage increases. The purpose of the shunt field is to decrease the amount of excitation required from the battery field.

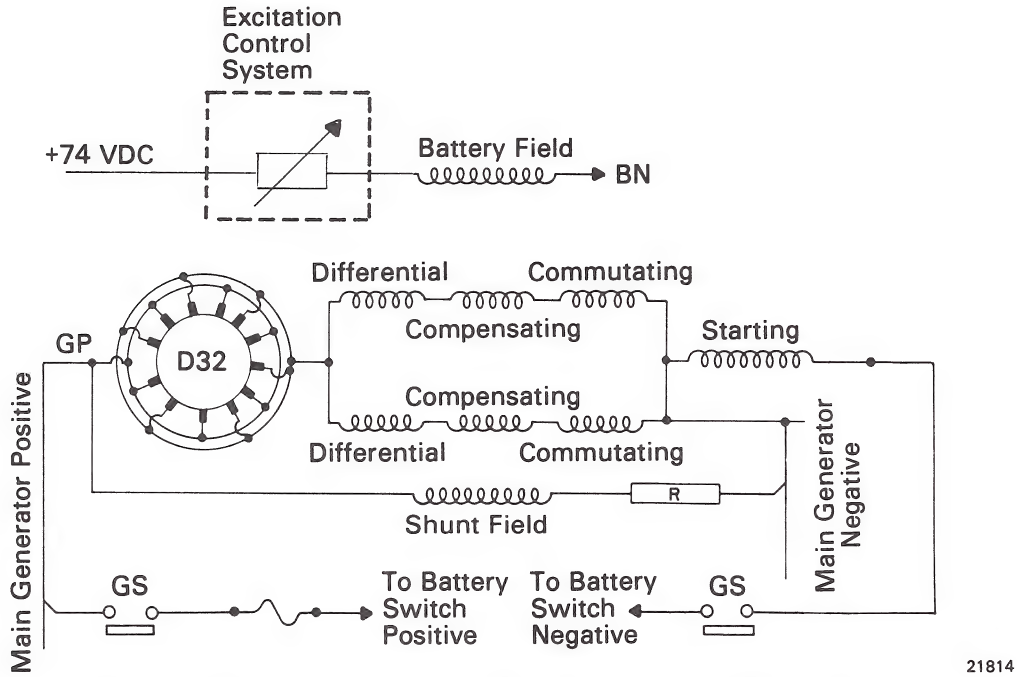

Fig.D32-1 – Generator, Simplified Schematic Diagram

An external resistance is connected in series with the shunt field. The value of the external resistance is determined by the horsepower required from the locomotive and the desired operating characteristics of the locomotive.

DIFFERENTIAL FIELD

The differential field is connected in series with the armature and load and is connected to oppose the battery field. This gives the generator a drooping load characteristic. Therefore, an increase in load current results in a decrease in terminal voltage unless the increase in load current is accompanied by an increase in excitation to the battery field.

This drooping load characteristic is desirable so that generator output approaches a constant kilowatt (volts times amperes) value as load current changes. The relatively small variation in output kilowatts can be compensated for with a very small change in excitation to the battery field. These small changes in excitation to the battery field is accomplished by the action of the excitation control system.

COMPENSATING FIELD

Load current flowing through the armature windings tends to set up a magnetic field at right angles to the main field. This causes the main field to be distorted and results in weakening of the field. The purpose of the compensating field is to cancel the effects the magnetic field produced by load current flowing through the armature.

The compensating windings are placed in the face of the main pole pieces and are connected in series with the armature. The windings are connected so that their magnetic field opposes the magnetic field set up by the armature. An increase in load current increases the armature magnetic field and the magnetic field set up by the compensating windings so that the effect of the two fields are cancelled.

COMMUTATING FIELD

The load current flowing through an armature coil flows in one direction as the leading side of the coil makes contact with the leading edge of the brush. In order to obtain sparkless commutation, current flow through the coil must reverse before the trailing edge of the coil leaves the trailing edge of the brush. However, the voltage induced in the coil due to self inductance delays the current reversal and results in sparking at the brushes.

Commutating poles are used to assist in the reversal of current through the coil undergoing commutation. Commutating poles are small poles placed between the main poles. The windings on the commutating poles are in series with the armature and are connected so that the magnetic field from the commutating poles neutralizes the effects of armature coil self inductance. This allows current reversal in the coil undergoing commutation to occur at the proper time to prevent sparking at the brushes.

OPERATION

Main generator output is controlled by engine speed and battery field excitation. Engine speed at throttle 1 position is approximately 315 RPM and increases in steps as the throttle is advanced. Engine speed at throttle 8 position is approximately 900 RPM. This change in engine speed is controlled by the governor.

The excitation reference voltage to the load regulator also increases in steps as the throttle is advanced. Therefore, each throttle position results in a specific engine speed and a specific value of excitation reference voltage to the load regulator. At throttle 1, this reference voltage is about 7 volts and increases to about 37 volts at throttle 5 through 8.

The generator characteristic curves shown in Fig. D32-2 represent maximum output that is available from the main generator at each throttle position with fixed levels of excitation to the battery field (load regulator in maximum field position). These curves represent maximum operating limits for each throttle position but they are not the most efficient points of operation.

More efficient operation, especially at the higher throttle positions, is obtained by providing for a specific constant horsepower output at each throttle position. This is accomplished by first adjusting the engine speed governor for a specific engine speed at each throttle position, then determining the required excitation to obtain the desired power for each throttle position. The power piston of the engine speed governor is then adjusted so that the desired power throughout most of the normal speed range is obtained when the load regulator brush arm is in a balanced position (between minimum and maximum field position).

The constant horsepower curves shown in Fig. D32-3 are obtained by action of the engine speed governor and load regulator. A brief description of this action is provided in Section 7B-LR.

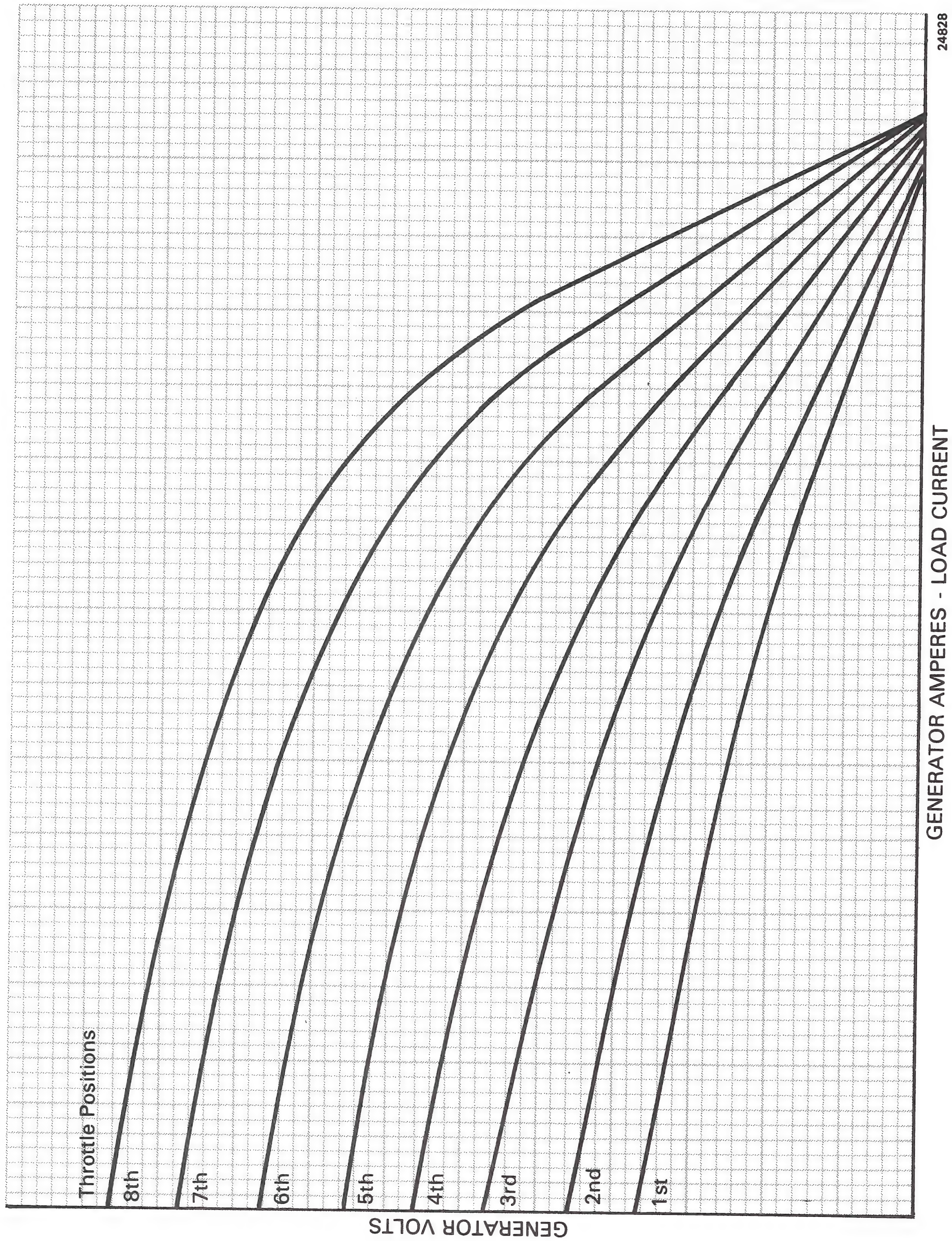

Fig.D32-2 – Nominal Generator Characteristics Curves At Fixed Levels Of Excitation

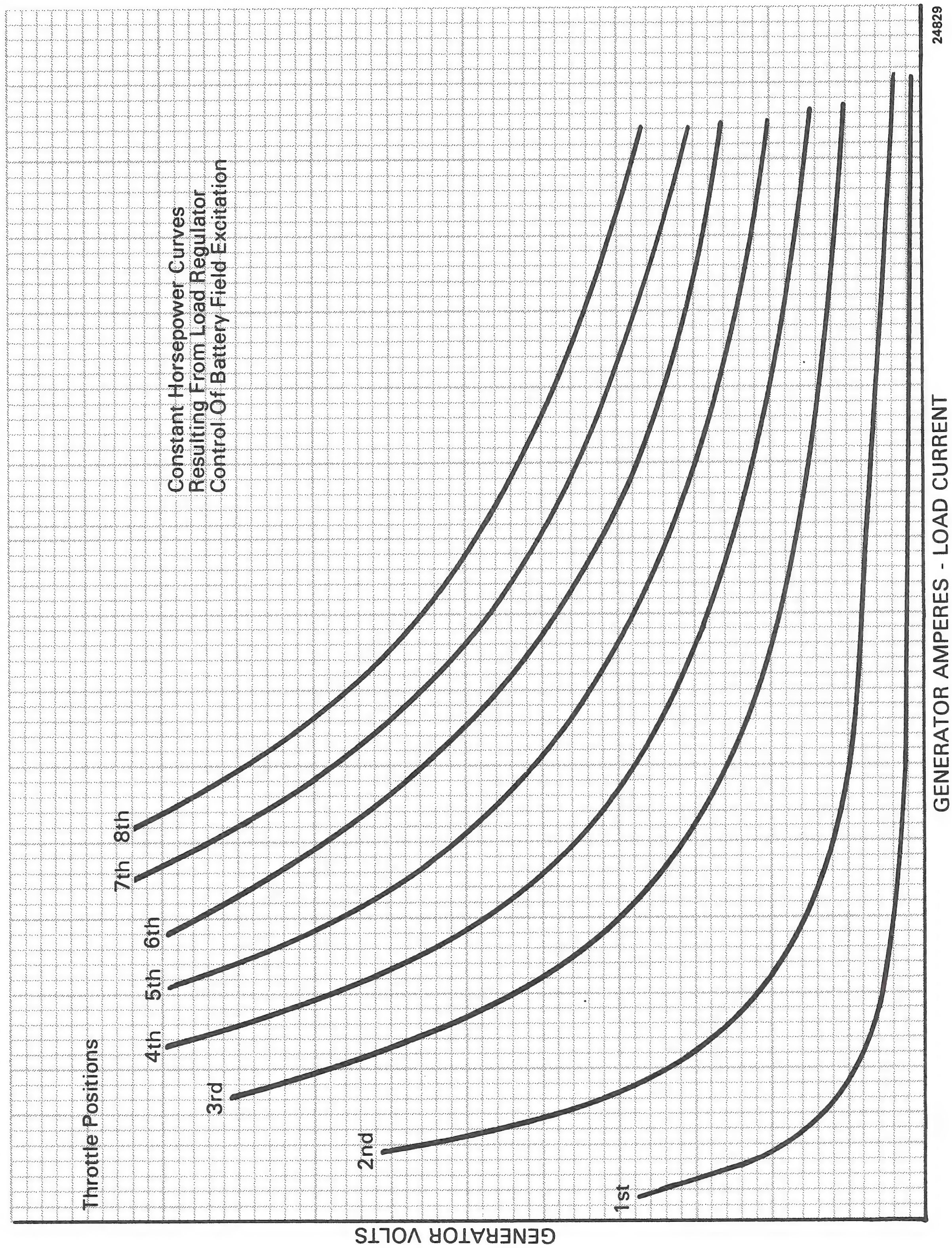

Fig.D32-3 – Constant Kilowatt (Horsepower) Curves – Nominal

The D32 generator has a residual magnetic flux, but the resistance connected in series with the generator shunt field prevents the residual from building up more than a negligible amount of voltage when the machine is running without its battery field excited.

When the battery field is excited at fixed levels, output takes on the generator characteristics shown by the curves in Fig. D32-2. The curves are approximate, but they illustrate that at low engine speed, maximum current and voltage remain at low values. The values increase as the throttle and generator rotating speed are advanced, but both load current and voltage are automatically limited by the characteristics of the generator.

The shape of the curves in Fig. D32-2 is obtained by use of fixed levels of battery field current and application of the generator differential field. The generator characteristics do not achieve the constant horsepower loading desirable for efficient and economical operation of the diesel engine.

The constant horsepower curves desired are shown in Fig. D32-3. These characteristics are obtained by action of the engine governor on a potentiometer-connected variable rheostat (load regulator). The load regulator provides a reference signal to an EC (excitation control) module, which compares the signal to a battery field reference signal and triggers controlled rectifier BF-SCR output to the main generator battery field.

The engine governor is adjusted to operate at a steady state or balanced condition and to provide the engine with a specific amount of fuel when the throttle calls for a specific engine speed. This specific amount of fuel and specific engine speed, along with load regulator action, bring about specific horsepower at the balanced condition.

If the train begins to slow down as when climbing a hill, traction motor resistance changes, and the load on the engine as indicated by the curves in Fig. D32-2 would tend to move into an overload area, Fig. D32-4. More fuel would be required to maintain the engine speed called for by the engine governor. Governor linkage would move away from the steady state or balanced condition. When this occurs, a valve in the governor admits oil under pressure to a vane motor that drives the load regulator rheostat. The rheostat turns to change generator excitation and consequently engine load is changed. When governor linkage again achieves the balanced condition, oil is no longer admitted to the load regulator motor. It stops at a position resulting in generator volts and amperes falling on the constant horsepower curve.

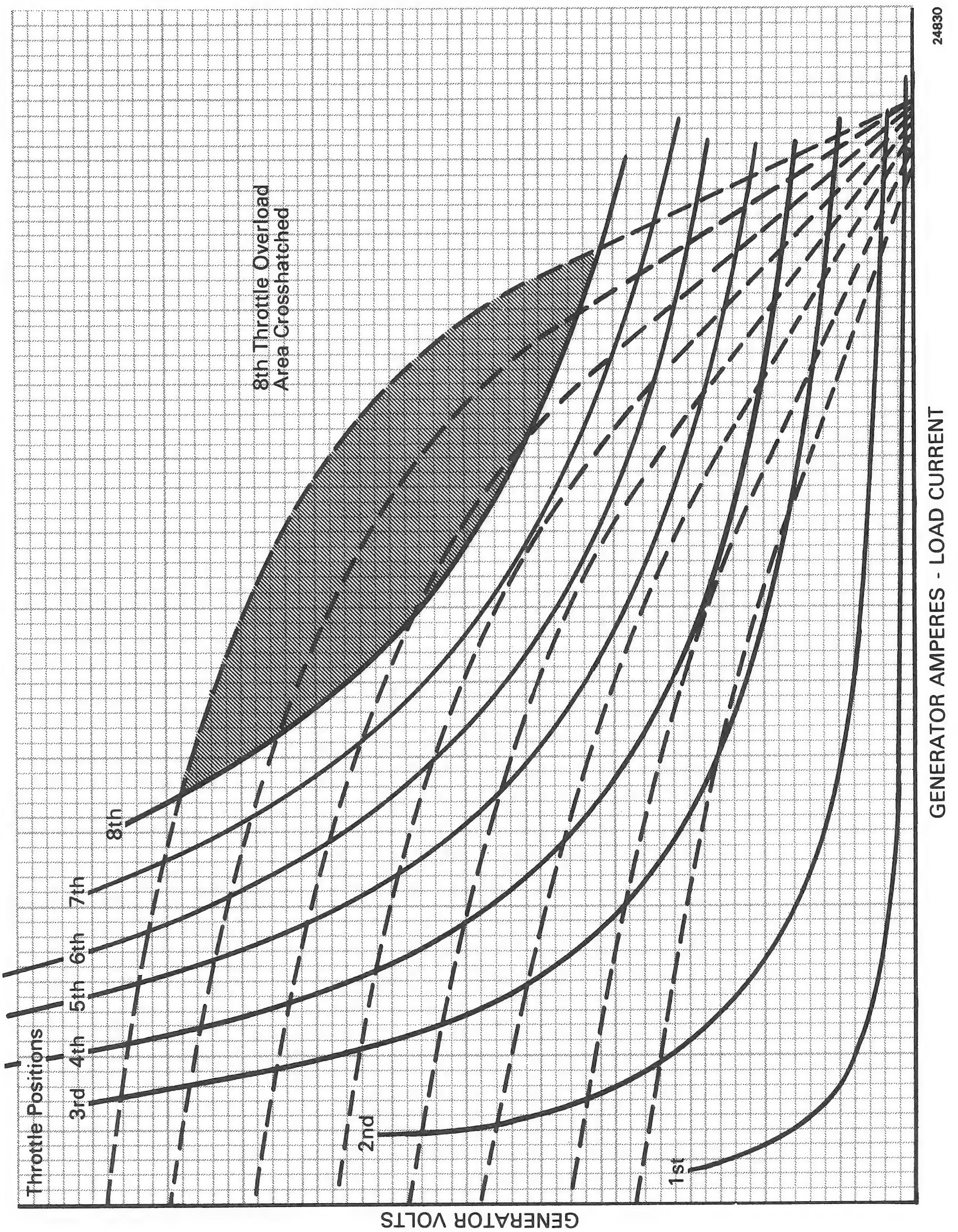

Fig.D32-4 – Constant Horsepower Curves Superimposed Upon Generator Characteristics Curves

VOLTAGE REGULATOR MODULE, VR

INTRODUCTION

The voltage regulator module VR is a solid-state voltage regulator designed to maintain output voltage of the auxiliary generator to within ± 1 volt of the "set point." The VR module is usually adjusted for a nominal output voltage of 74 volts from the auxiliary generator, but can be adjusted for any output between 71 and 77 volts. The VR module will maintain the output to within ± 1 volt of the "set point" at auxiliary generator rotating speeds between 825 and 3,000 RPM, at any load between no load and full rated load and within a temperature range of -40° C to +80° C.

The VR module contains a starting circuit, a detector circuit, a power circuit, and an oscillator circuit. A simplified schematic diagram of a typical VR module, Fig. VR-1, should be used for reference only. The locomotive wiring diagram should be used when performing troubleshooting or maintenance.

The output voltage of the auxiliary generator is regulated by opening and closing the power circuit to the generator field. This is accomplished by controlling conduction of the silicon controlled rectifier SCR1. Conduction of SCR1 is controlled by the detector circuit and the oscillator circuit. SCR1 is gated on by the detector circuit if the output

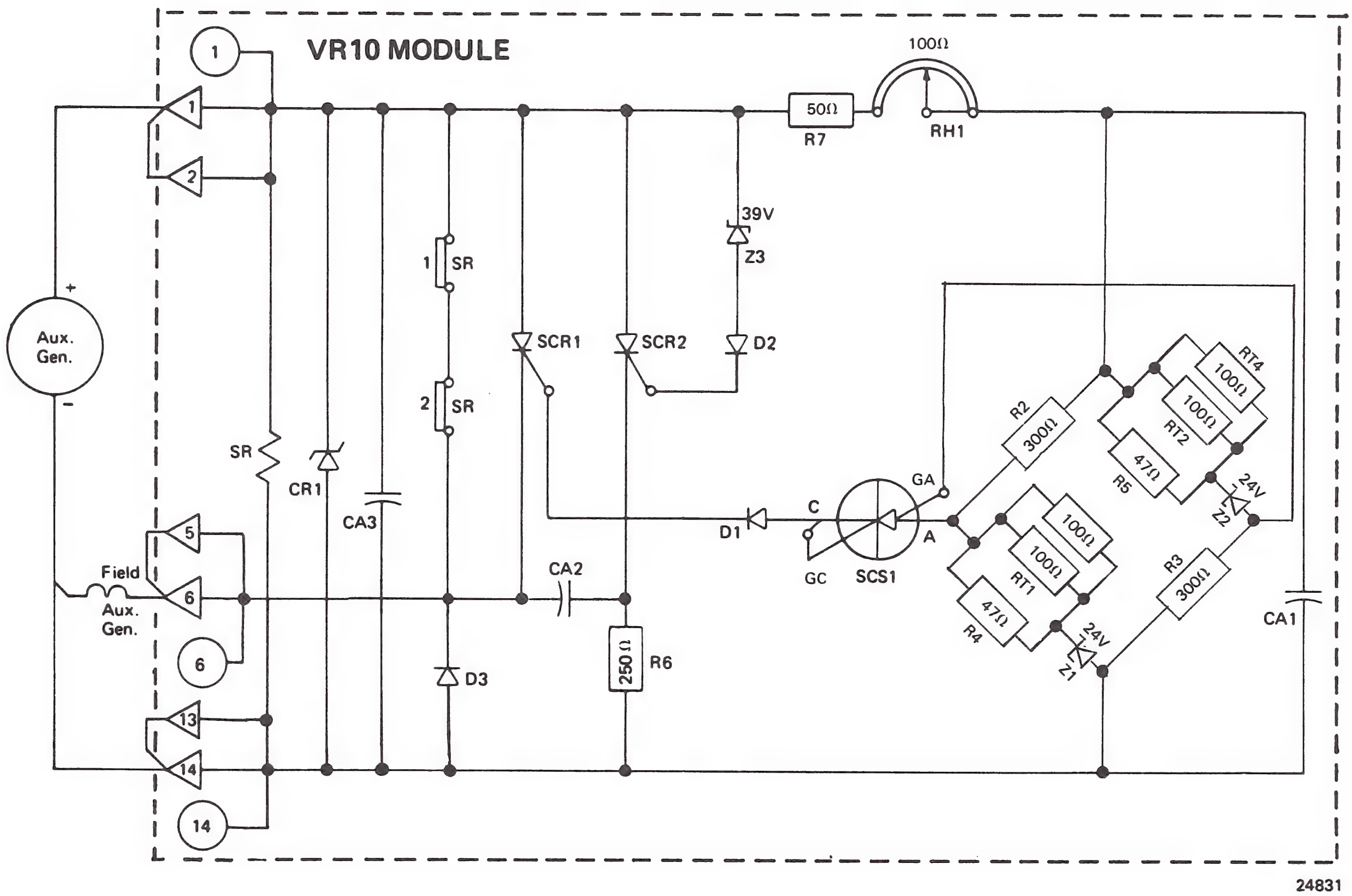

Fig.VR-1 – Voltage Regulator Module, Simplified Schematic Diagram

voltage of the generator is below the "set point." After being turned on SCR1 will continue to conduct until a positive pulse is applied to its cathode. The oscillator circuit provides a positive pulse to the cathode of SCR1 once during each cycle of oscillation. SCR1 will remain off if the output voltage of the generator is above the "set point" when the positive pulse is received from the oscillator. If the output is below the "set point" SCR1 will be turned on by the detector circuit as soon as the positive pulse from the oscillator is removed.

The positive pulses from the oscillator circuit occur often enough to prevent any noticeable difference in field strength between pulses. When SCR1 is turned off, generator field tends to collapse, however, the current generated by the decaying field flows through diode D3 causing a gradual decay instead of a sudden collapse. The gradual decay of the field, frequency of oscillations from the oscillator, and the response of the detector and power circuits results in a stable output from the auxiliary generator.

STARTING CIRCUIT, Fig. VR-2

The starting circuit consists of a starting relay SR with two sets of normally closed contacts. The SR coil is connected to the output of the auxiliary generator. The SR contacts, in series with the auxiliary generator field, is also connected to the output of the auxiliary generator.

During normal operation, excitation current to the field is supplied through a silicon controlled rectifier SCR1. However, during start up generator excitation is provided by residual magnetism and the output is not large enough to cause turn on of SCR1. Therefore, the normally closed contacts of SR are connected so that SCR1 is bypassed during voltage buildup. The SR relay is designed to pick up after the generator output voltage is large enough to turn on SCR1. After pickup of SR the bypass circuit is open and excitation to the field is supplied through SCR1.

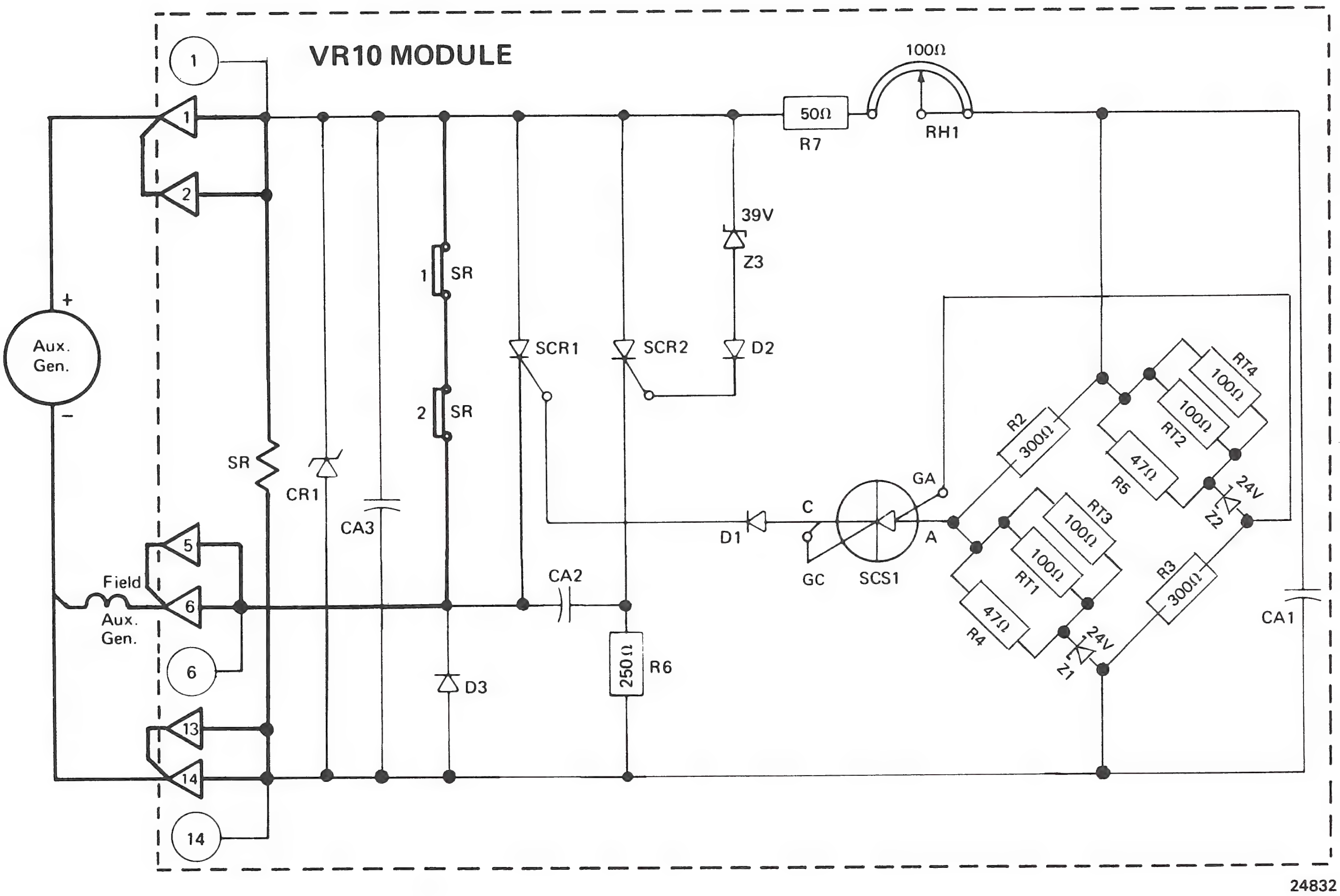

Fig.VR-2 – Voltage Regulator Starting Circuit, Simplified Schematic Diagram

DETECTOR CIRCUIT, Fig. VR-3

The detector circuit consists of a silicon controlled switch SCS1 and a voltage divider consisting of resistor RE7, rheostat RH1, and a zener diode bridge circuit with temperature compensating resistors.

The silicon controlled switch SCS1 remains off until forward bias is applied between the anode and cathode and a negative potential is applied to the anode gate in respect to the anode. After conduction starts the anode gate loses control and conduction will continue as long as the anode is positive in respect to the cathode.

The gating signal, potential between anode "A" and anode gate "GA" is provided by the zener bridge. The zener bridge is balanced, potential at "X" is equal to the potential at "Y," when output voltage of the generator is at the "set point." When the bridge is balanced, potential at the anode is equal to the potential at the anode gate and no gating signal is applied to SCS1.

If generator output voltage decreases, the bridge will become unbalanced. The potential at "Y" decreases and the potential at "X" will remain almost constant. The decrease in potential at "Y" with respect to "X" places a negative potential on the anode gate in respect to the anode. This causes SCS1 to conduct. Conduction of SCS1 places a positive potential on the gate of SCR1 causing SCR1 to conduct.

Conduction of SCR1 causes the potential on its cathode to rise to a value which is almost equal to the positive potential of the generator. This positive potential places reverse bias on SCS1 causing SCS1 to turn off. SCR1 continues to conduct until the oscillator circuit places reverse bias on SCR1. Reverse bias from the oscillator circuit results in turn off of SCR1, but SCS1 will apply a gating signal to SCR1 causing turn on if the anode gate of SCS1 is still negative with respect to the anode of SCS1. This process continues until output voltage of the generator rises to the "set point." The bridge is balanced when generator output voltage reaches the "set point" and no gating signal is applied to SCS1 or to SCR1. Therefore, the detector circuit tends to maintain generator output voltage at the "set point."

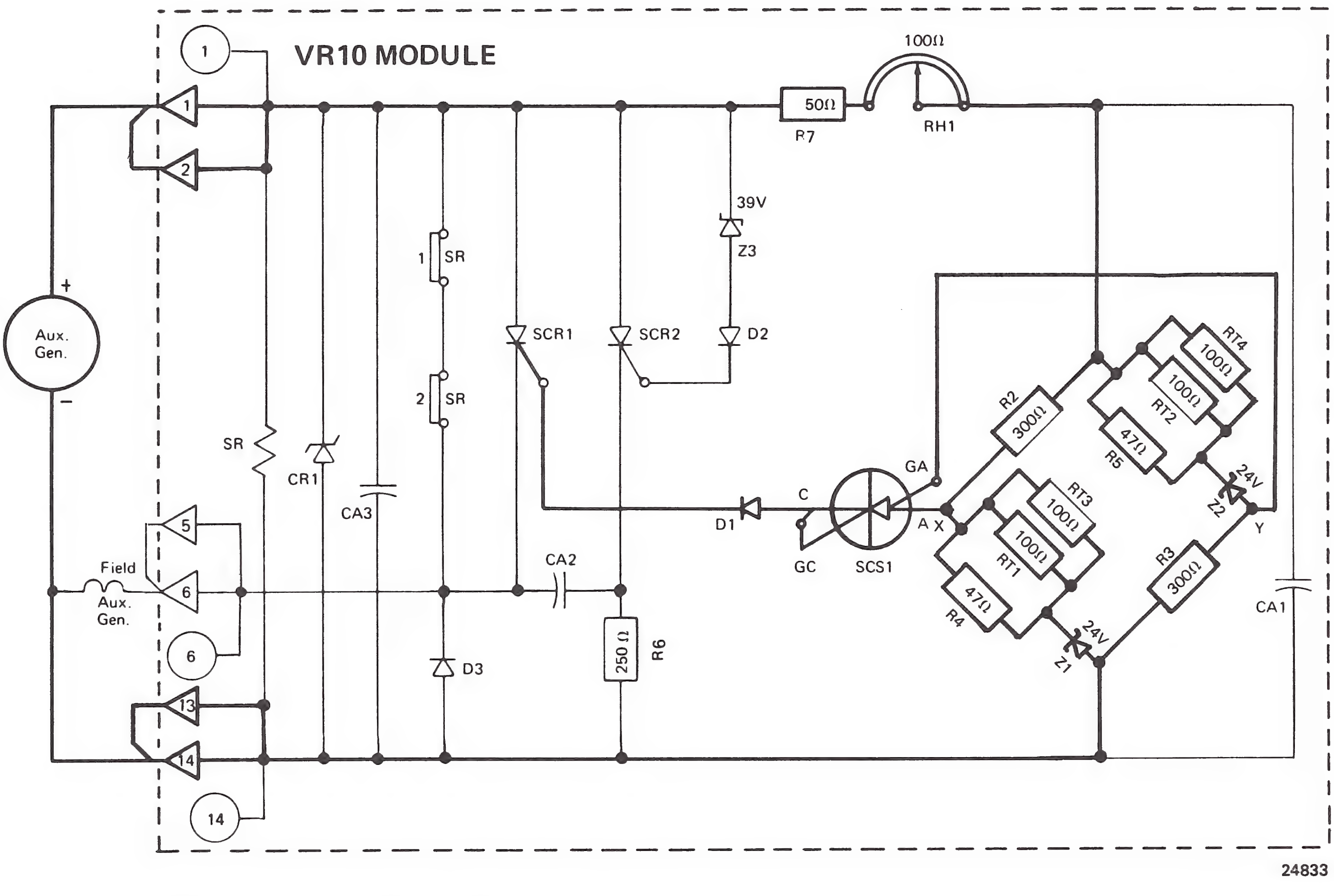

Fig.VR-3 – Voltage Regulator Detector Circuit, Simplified Schematic Diagram

Negative temperature coefficient resistors, RT1 and RT2, are used in the bridge circuit to provide thermal compensation. The resistance of RT1, RT3, RT2, and RT4 decreases as temperature increases, whereas resistance of R2, R3, R4, R5, R7, and RH1 increases as temperature increases. Therefore, the decreases in resistance of RT1 and RT2 compensates for increase in resistance R2, R3, R4, R5, R7, and RH1 as temperature increases and the increase in resistance of RT1, RT3, and RT2 and RT4 compensates for a decrease in resistance as temperature decreases.

GENERATOR FIELD EXCITATION POWER CIRCUIT, FIG. VR-4

Excitation current for the auxiliary generator field is supplied through the silicon controlled rectifier SCR1. SCR1 is turned on by conduction of SCS1 in the detector circuit when the output voltage of the generator falls below the "set point" of the voltage regulator. After turn on, SCR1 continues to conduct until a positive pulse from the oscillator circuit applies reverse bias to SCR1.

This positive pulse from the oscillator circuit results in turn off of SCR1. However, SCS1 in the detector circuit will apply a gating pulse to SCR1 causing turn on, as soon as the positive pulse is removed, if generator output voltage is below the "set point." When output voltage is equal to or greater than the "set point," SCS1 will not conduct and no gating pulse is applied to SCR1 until the output voltage falls below the "set point."

The generator field tends to collapse when SCR1 is turned off. However, self inductance of the field induces a voltage into the field windings which causes current flow through diode D3 and results in a gradual decay of the field instead of a sudden collapse. The gradual decay of the field, frequency of oscillations from the oscillator, and the response of the detector and power circuits result in a stable output from the auxiliary generator.

OSCILLATOR CIRCUIT, Fig. VR-5

After SCR1 starts conducting it continues to conduct until the cathode becomes positive with

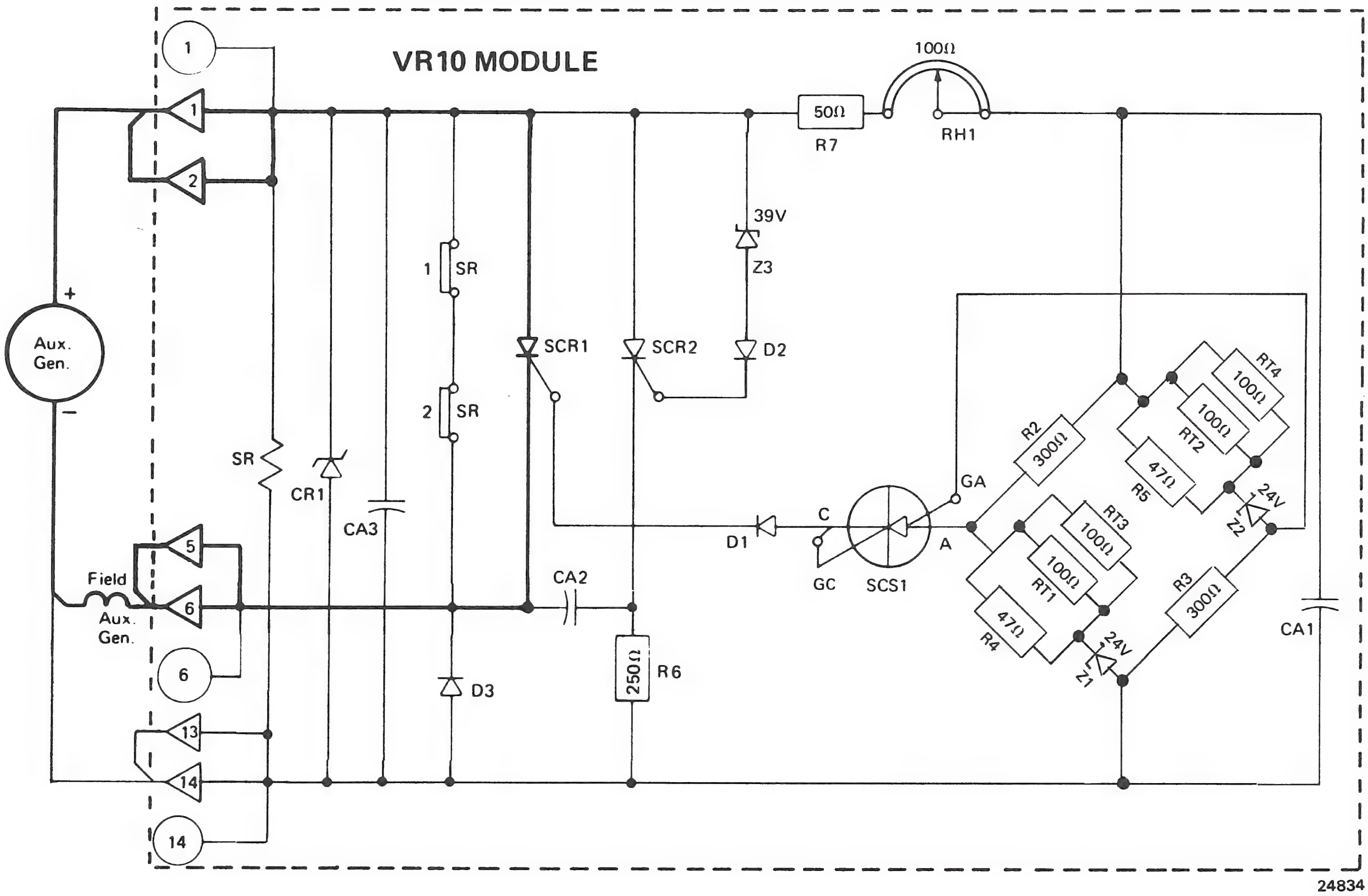

Fig.VR-4 – Voltage Regulator Power Circuit, Simplified Schematic Diagram

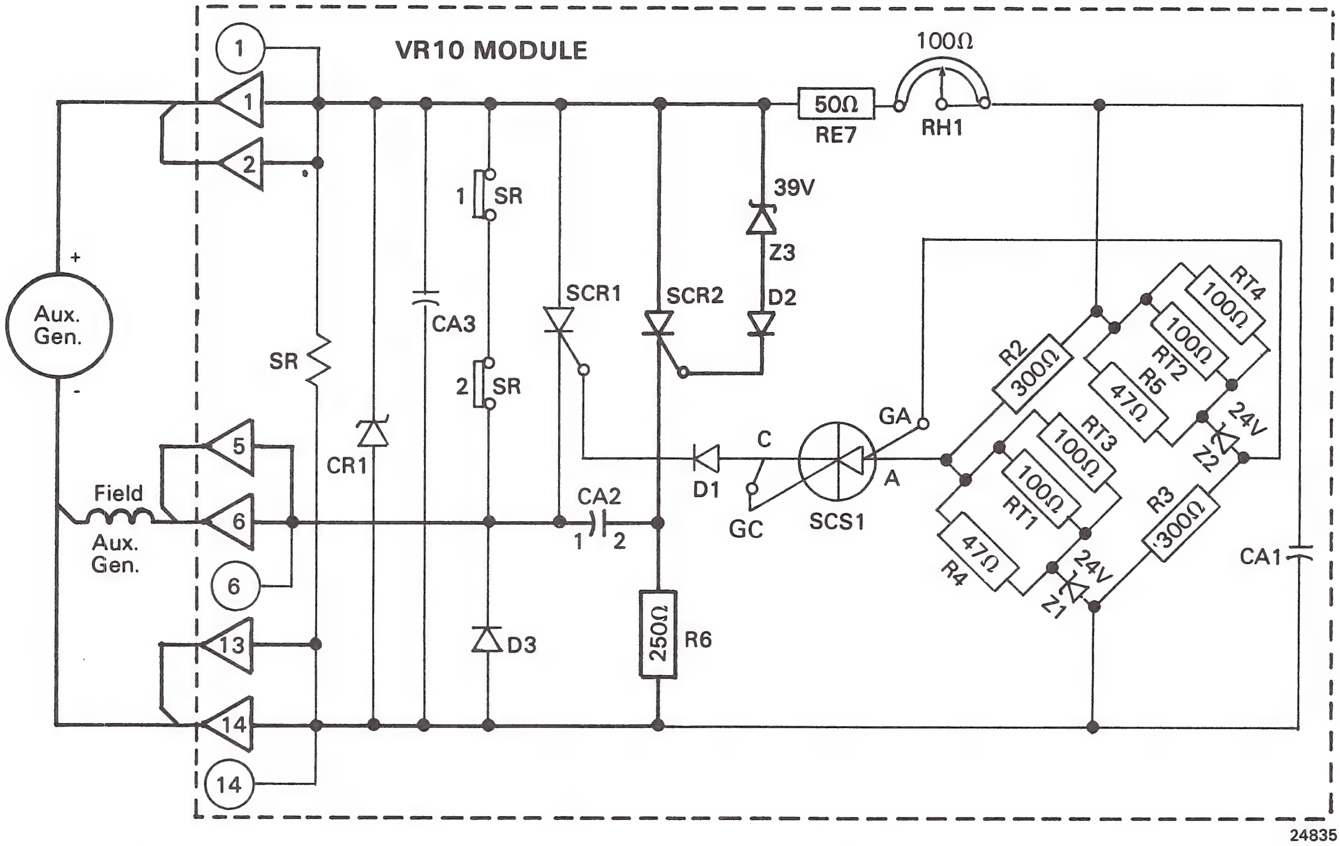

Fig.VR-5 – Voltage Regulator Oscillator Circuit, Simplified Schematic Diagram

respect to the anode. If SCR1 remained on, the output voltage of the generator would increase to the saturation level. The oscillator circuit consisting of silicon controlled rectifier SCR2, diode D2, zener diode Z3, capacitor CA2, and resistor R6 provides a positive pulse to the cathode of SCR1 once during each oscillation. These positive pulses from the oscillator apply reverse bias at intervals of three milliseconds or less causing SCR1 to turn off. SCR1 will be turned on again by a pulse from SCS1 in the detector circuit if the output voltage of the generator is below the "set point" when the positive pulse is removed from the cathode of SCR1. If the output voltage of the generator is equal to or greater than the "set point," SCS1 in the detector circuit remains off and no gating pulse is applied to turn on SCR1.

Assume that SCR1 is conducting and capacitor CA2 has a positive charge of 74 volts on plate 1 in respect to plate 2. Zener diode Z3 fires and applies a positive pulse to the gate of SCR2. This positive pulse causes SCR2 to turn on. Turn on of SCR2 causes the voltage on the cathode of SCR2 and on plate 2 of CA2 to rise to approximately 74 volts. This forces Z3 to cut off and removes the gating signal, but SCR2 will continue to conduct as long as the anode is positive with respect to the cathode.

The sudden increase in voltage on plate 2 of CA2 causes a corresponding momentary increase in the voltage on plate 1 and on the cathode of SCR1. The reason for the momentary increase in voltage on plate 1 of CA2 is that the difference in the voltage across the plates cannot change instantaneously. Therefore, the voltage on plate 1 and on the cathode of SCR1 increases to a value higher than the output voltage of the generator. This results in turn off of SCR1 and permits capacitor CA2 to charge up so that plate 2 is positive with respect to plate 1. SCR1 will turn on again as soon as the cathode is negative with respect to the anode provided SCS1 applies a gating signal to the gate of SCR1.

The average nominal output voltage of the generator is 74 volts, but the actual output contains commutation ripples that rise above and fall below the 74 volt value. With SCR2 turned on CA2 will charge up to a value near the peak of the commutation ripple. SCR2 will be reversed biased causing turn off when the generator output falls below the value of the charge on CA2. Capacitor CA2 discharges through R6 when SCR2 is turned off.

Zener diode Z3 turns on when the charge on CA2 falls below 39 volts. Turn on of Z3 results in a repeat of the cycle. The cycle is repeated at intervals of 3 milliseconds or less.

EXCITATION AND POWER CONTROL SYSTEM

This section provides a general description of the excitation and power control system. Description of the system is followed by a detailed description of typical modules and assemblies used in the system. Simplified schematic diagrams of the modules are provided for convenient reference. The locomotive wiring diagram should be used when performing troubleshooting or maintenance.

DESCRIPTION

A flow diagram of the excitation and power control system is provided in Fig. 7B-1. Electrical power and electrical control signals are represented in the flow diagram by solid interconnecting lines. Mechanical and hydraulic signals are represented by broken interconnecting lines.

The throttle switches receive 74 volts DC input from the auxiliary generator. The 74 volts applied to the throttle switches is used to energize the speed setting solenoids in the engine speed governor.

The speed setting solenoids in the engine speed governor are energized individually or in combination depending upon throttle position. The speed setting solenoids change the speed characteristics of the engine speed governor so that the governor will maintain a different engine speed for each throttle position. The nominal engine speed for each throttle position is given in Fig. 7-B1.

Part of the auxiliary generator output is provided to the battery field silicon controlled rectifier assembly BF-SCR to excite the main generator battery field. Output from the BF-SCR is determined by the excitation control module EC1. The EC1 module responds to signals related to main generator output, throttle position, and load regulator position. Output from the main generator is applied to the traction motors.

The throttle switches provide input signals to the EC1 module. These signals are modified and provided to the load regulator LR. Therefore, the voltage applied to the load regulator is determined by throttle position. The nominal value of the EC module output voltage is given in Fig. 7B-1.

The reference signal from the wiper arm of LR is compared to the voltage applied to the main generator battery field. Gating pulses are applied to the battery field silicon controlled rectifier BF-SCR when the LR reference signal is larger than the battery field voltage. This increases excitation to the battery field. The gating pulses are removed from BF-SCR when the battery field voltage is larger than the LR reference signal. This decreases excitation to the battery field. This action results in maintaining battery field excitation at a level proportional to the LR reference signal which is related to throttle position. Therefore, the load on the diesel engine as well as engine RPM is determined by throttle position.

Refer to description of individual modules and components for a detailed description of components used in the excitation and power control system.

CONTENTS

The contents of Section 7 Part B are presented in the following order.

Throttle Position	Engine RPM	*EC Output Volts
Low Idle	235	
Idle	318	
Fast Idle	517	
1	318	7
2	366	18
3	517	22
4	570	33
5	676	37
6	730	37
7	848	37
8	904	37

*Approximate value between test panel test points TP6 and TP10 with battery field fuse open.

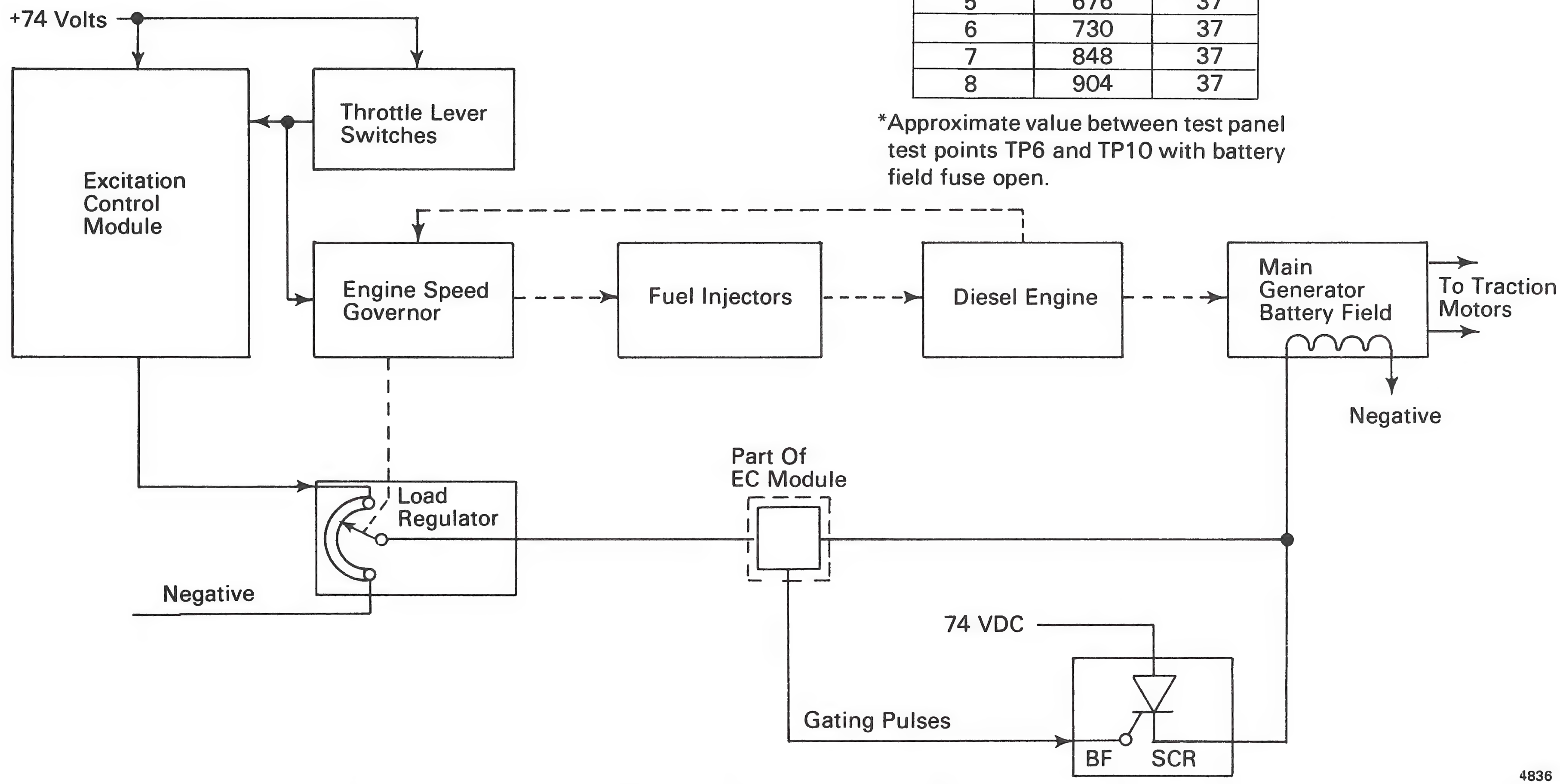

Fig.7B-1 – Excitation And Power Control System, Simplified Flow Diagram

GOVERNOR CHARACTERISTICS

When the throttle is in idle and the Service Selector Switch is in ROAD or SERIES position, the overriding solenoid ORS, Fig. 7B-2, is energized, allowing governor pressure oil to raise the load regulator pilot valve. Engine pressure oil then drives the load regulator to minimum field position. ORS action is required because the governor linkage is set to position the load regulator pilot valve for fast load regulator action. Without ORS action this would place the load regulator at maximum field position for starting.

1. When the throttle is advanced, the overriding solenoid ORS is de-energized. The load regulator pilot valve lowers, and engine pressure oil moves to drive the load regulator toward maximum field position.

2. Governor solenoids A, B, and C press down independently or in combination on the speed setting plate in the engine governor. In throttle positions Run 5 and 6, the D solenoid also presses down on the rotating chopper bushing.

3. The speed setting pilot valve is pressed down, and the rotating chopper bushing admits "chopped" oil under pressure to the speed setting piston. The piston moves down at a controlled rate to increase compression of the speed setting spring.

4. Spring pressure causes the governor flyweights to move inward.

5. The speed control valve piston moves down, and "unchopped" pressure oil is admitted under the governor power piston. The power piston moves upward, causing the governor terminal shaft to turn, which causes the fuel injector rack gears to move into the injectors and increase the quantity of fuel injected into the engine cylinders.

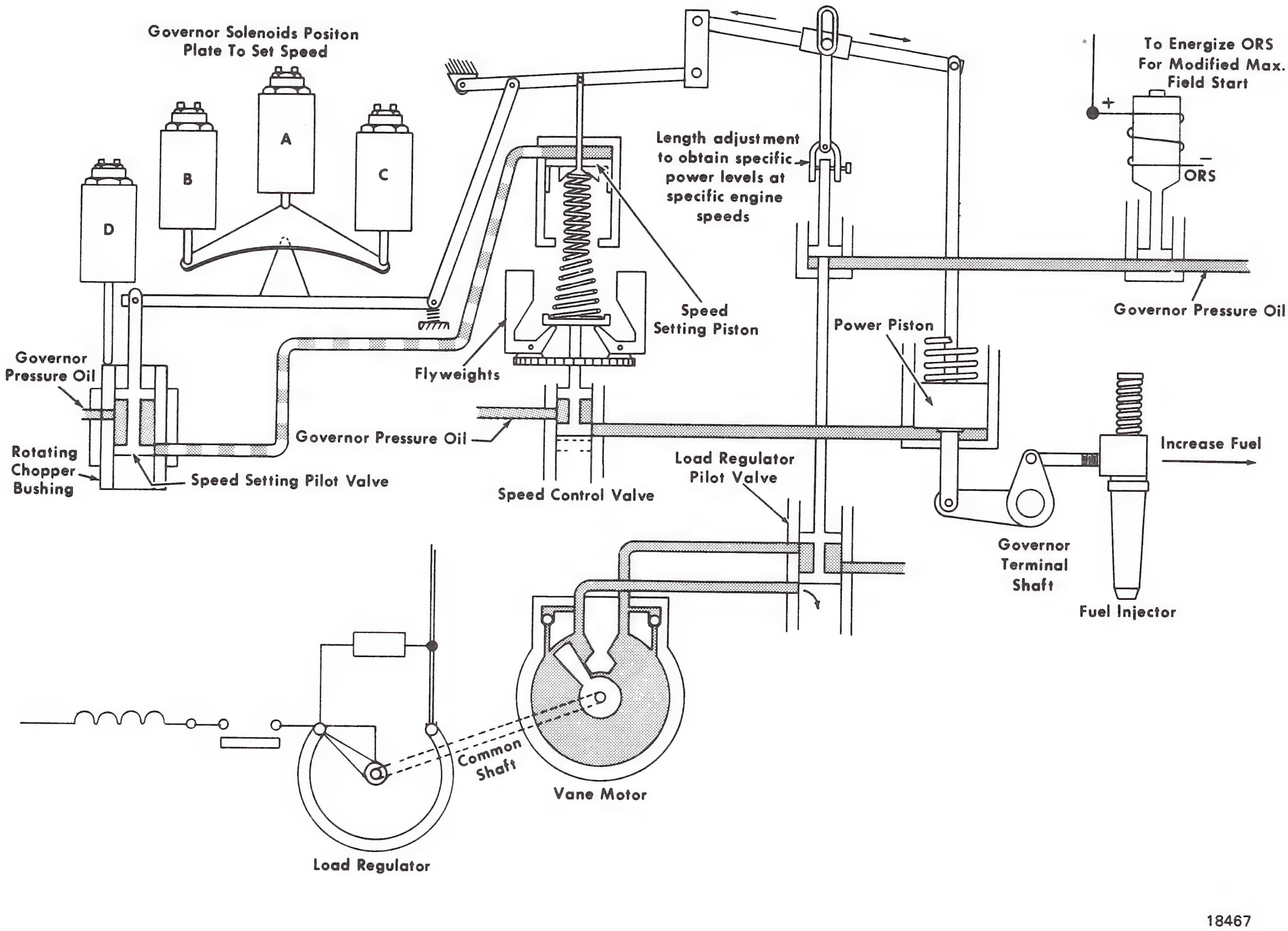

Fig.7B-2 - Governor And Load Regulator, Simplified Schematic Diagram

6. When the speed setting piston has compressed the speed setting spring the amount called for by movement of the governor solenoid plate, linkage causes the speed setting pilot valve to move up to shut off the supply of "chopped" oil. When engine speed has increased sufficiently, the flyweights move outward, raising the speed control piston, and shutting off the supply of pressure oil to the power piston.

7. The power piston, under the influence of "unchopped" oil had moved upward quickly, while the speed setting piston (being driven by "chopped" oil) moved downward at a slower rate. The difference in movement brought about elevation of the load regulator pilot valve.

8. The load regulator pilot valve piston moved up to cut off the supply of engine pressure oil at the load regulator vane motor.

9. When the speed setting piston is at the position called for by the solenoids, the following must occur in order to achieve a balanced steady state condition.

   a. The position of the flyweights (engine speed) must be such that the speed control valve is closed.

   b. The power piston must be positioned so that the load regulator pilot valve is closed.

10. If the power piston is not at a position to close the regulator pilot valve, the load regulator will move toward either maximum or minimum field position. The resulting increase or decrease of load on the engine will tend to change engine speed.

11. The change in engine speed will bring about movement of the speed control valve with a resulting change in power piston position.

12. When the position of the power piston, along with the position of the load regulator, result in closed speed control and load regulator pilot valves, a balanced condition is achieved. The balanced condition generally results in generator voltage and generator current (horsepower) at a value somewhere on one of the curves shown in Fig. 7B-2.

Changing the length of the rod connected to the load regulator pilot valve will change the position of the power piston at the balanced condition, and it is this length adjustment that is used to obtain the specific horsepower wanted for a specific throttle position.

BATTERY FIELD SILICON CONTROLLED RECTIFIER ASSEMBLY, BF-SCR

Excitation current to the main generator battery field is provided through the battery field silicon controller rectifier assembly BF-SCR, Fig. BF-SCR1. The amount of excitation provided by BF-SCR is controlled by the excitation control module EC1.

The battery field contactor BF is energized by advancing the throttle to No. 1 position. Pickup of BF provides +74 VDC to the anode of SCR1 and SCR2 on BF-SCR. A gating signal is provided from module receptacle 4 of the EC module through D1 to SCR1. Turn on of SCR1 provides excitation current to the battery field and also charges capacitor C1 on BF-SCR through R1. When SCR1 fires, a voltage of +74 VDC is placed on the cathode of SCR2 and on plate 2 of C1. Voltage on the cathode of SCR2 and on plate 2 of C1 decreases as capacitor C1 charges. A gating signal of about 37 VDC is applied from module receptacle 6 of EC through D2 to SCR2 on BF-SCR. This gating signal causes SCR2 to fire when voltage on the cathode of SCR2 decreases below the value of the gating signal applied to SCR2 (about 37 VDC).

Turn on of SCR2 causes the potential on plate 2 of C1 to rise immediately to +74 VDC. This is a rise of approximately +37 VDC. This voltage rise of +37 VDC is coupled through C1 to the cathode of SCR1 and results in turn off of SCR1.

The output of SCR2 charges capacitor C1 through the battery field. Voltage on plate 1 of C1 and on cathode of SCR1 decreases as C1 charges. Silicon controlled rectifier SCR1 fires when the voltage on plate 1 of C1 and on the cathode of SCR1 falls below the gating signal applied through D1.

Turn on of SCR1 causes the potential on plate 1 of C1 to rise immediately to +74 VDC. This voltage rise is coupled through C1 to the cathode of SCR2 and results in turn off of SCR2. Turn on of SCR1 also provides excitation current to the battery field.

The frequency of these oscillations is determined by the value of C1 and R1 on BF-SCR. The oscillations continue until the battery field reference signal increases above the LR reference signal. When this level is attained, the gating signal is removed from SCR1 on BF-SCR and SCR1 cannot fire. Gating signals are reapplied to SCR1 on BF-SCR when the battery field reference signal decreases below the LR reference signal. Refer to description of the EC module for control of gating signals to SCR1 on BF-SCR.

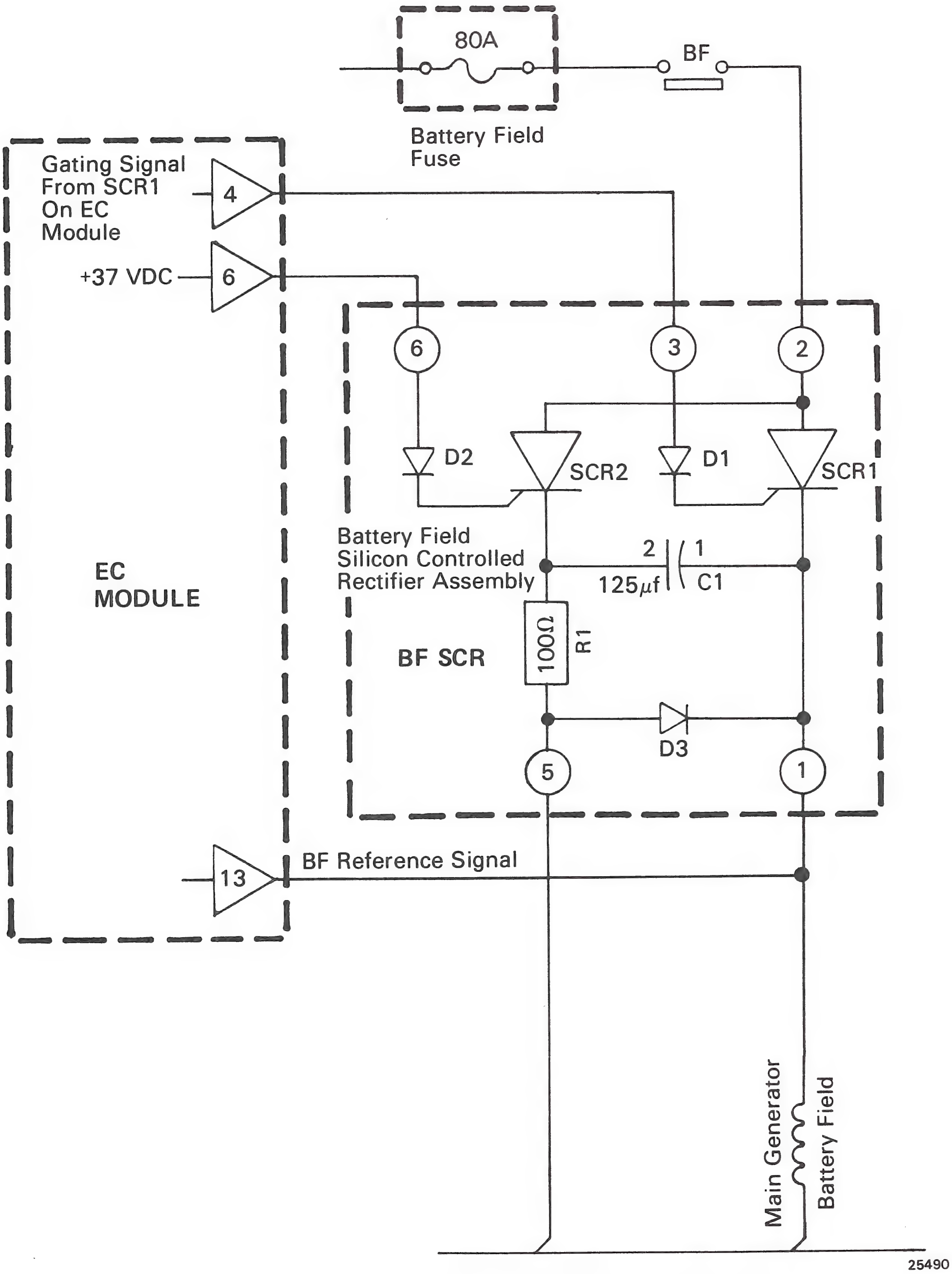

Fig.BF-SCR1 – Battery Field Silicon Controlled Rectifier Assembly, Simplified Schematic Diagram

EXCITATION CONTROL MODULE

INTRODUCTION

The excitation control module EC1 is designed to control battery field current to a value proportional to the load regulator reference signal. This is accomplished by using a transistor to compare the battery field reference signal to the load regulator reference signal.

The transistor turns on when the battery field reference signal is larger than the load regulator reference signal. Turn on of the transistor results in removing current from the battery field until the battery field reference signal decreases to a value below the load regulator reference signal. The transistor turns off when the battery field reference signal is smaller than the load regulator reference signal. Turn off of the transistor results in applying current to the battery field until the battery field reference signal rises above the load regulator reference signal.

A simplified schematic diagram of EC1 is provided in Fig. EC-1 for convenient reference. Refer to applicable locomotive wiring diagrams when performing maintenance or troubleshooting.

OPERATION

A signal proportional to throttle position is applied to rate control capacitor C1 through module receptacles 6, 7, 8, and 9. This signal is also applied to load regulator LR. Resistors R1, R2, R3, and R4 are selected to provide the desired signal to LR for each throttle position. Capacitor C1 is selected to provide the desired rate of change in the signal as the throttle is advanced or retarded.

The signal at the load regulator wiper arm, LR reference signal, is determined by throttle position, track speed, and load. The LR reference signal is applied to the base of transistor Q2.

A signal proportional to battery field current is applied to the emitter of Q2. Transistor Q2 is turned off when the LR reference signal is larger than the battery field reference signal (BF reference signal). Turn off of Q2 removes forward bias from Q1. With Q1 turned off, a gating signal is applied through R5, Z2, and D8 to SCR1 on the EC module. Turn on of SCR1 on the EC module provides a gating signal to SCR1 on the battery field silicon controlled rectifier assembly (BF-SCR). This results in an increase of current to the battery field and an increase in the BF reference signal.

Transistor Q2 turns on when the BF reference signal increases above the LR reference signal. Turn on of Q2 provides forward bias for Q1. Turn on of Q1 removes the firing signal from SCR1 on the EC module and results in removal of the firing signal from SCR1 or BF-SCR.

Turn off of SCR1 on BF-SCR removes current input from the battery field. However, the large inductance of the battery field results in a relatively slow decrease in the BF reference signal. Transistor Q2 turns off as the BF reference decreases to the level of the LR reference signal. Turn off of Q2 removes forward bias from Q1. Turn off of Q1 reapplies the gating signal to SCR1 on the EC module. This results in a gating signal to SCR1 on BF-SCR and reapplies a current input to the battery field. Therefore, Q2 compares the BF reference signal to the LR reference signal and operates to control battery field current at a level proportional to the LR reference signal and operates to control battery field current at a level proportional to the LR reference signal.

Refer to Section 7B Part BF-SCR for detailed description of the battery field silicon controlled rectifier assembly.

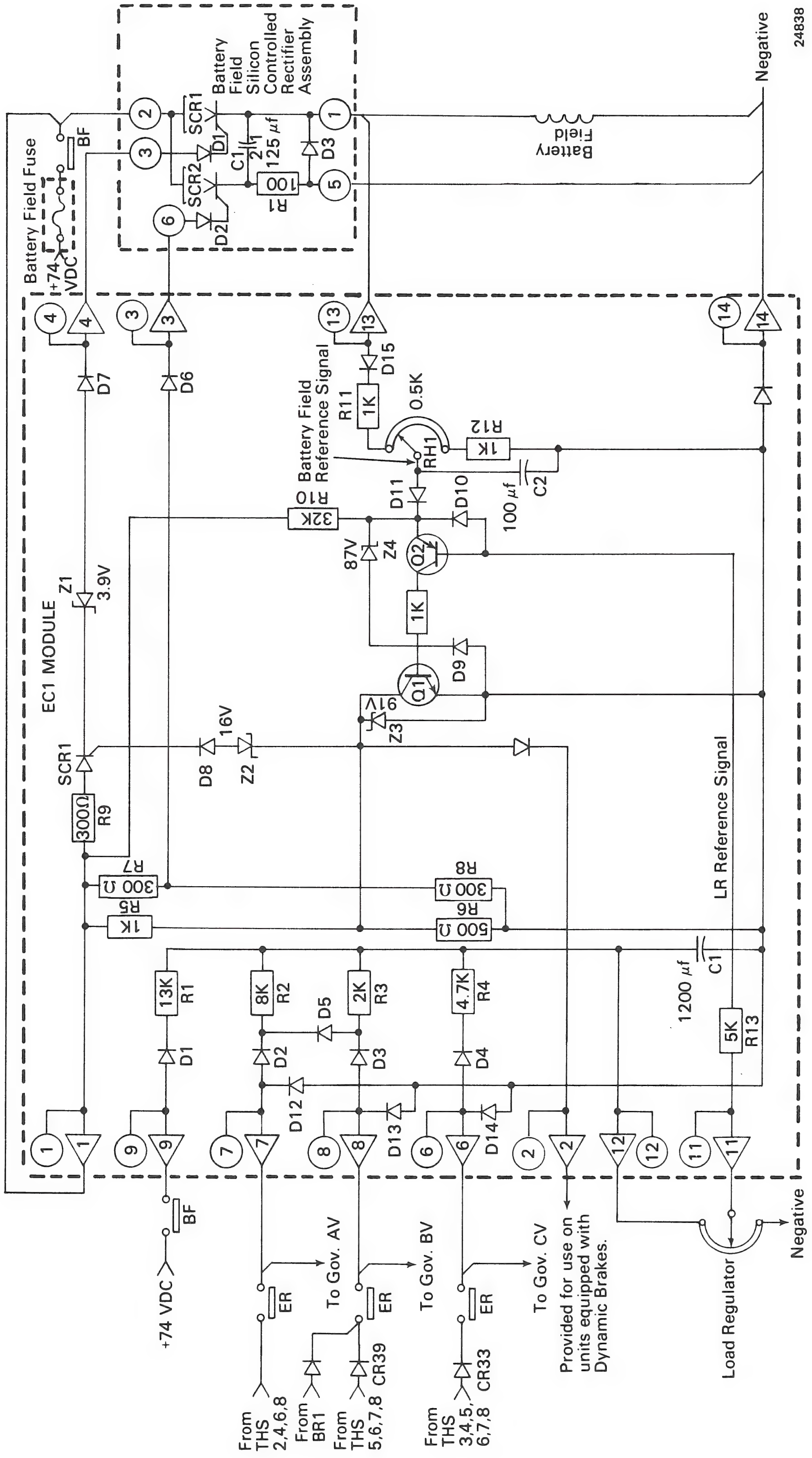

Fig.EC-1 – Excitation Control Module, Simplified Schematic Diagram

FS1 MODULE — FIELD SHUNTING

INTRODUCTION

The locomotive is equipped with four traction motors. These motors are connected across the main generator so that two parallel paths are provided for main generator current. Each parallel path consists of two motors connected in series. One step of motor field shunting is provided for the traction motor fields. Motor field shunting is initiated by the field shunting module FS1. The FS1 module consists of a detector stage and an output stage.

OPERATION

The detector stage, Fig. FS-1, contains a magsense amplifier with two control windings A1 and A2, a fixed bias winding A4, a controlled bias winding A3, an oscillator winding A5, and a center tapped output winding A6. The detector stage also contains a solid state comparator, an output transistor, and two opto-isolators to control current through controlled bias winding A3.

The oscillator winding A5 provides pulses (about 35 per second) to output winding A6. Polarity of the pulses is determined by the operating point established by bias windings A3 and A4, and control windings A1 and A2. Magnitude of the pulses increases as the operating point moves away from the +120 μa set point.

Bias windings A3 and A4 are negative sense windings which set the operating point to the left of the +120 μa set point when no current is flowing in control windings A1 and A2. Control winding A1 is a negative sense winding and tends to shift the operating point to the left. The A1 winding is excited by a signal proportional to main generator current. Control winding A2 is a positive sense winding and tends to shift the operating point to the right. The A2 winding is excited by a signal proportional to main generator voltage.

At low track speeds, main generator current is relatively high and main generator voltage is low. This results in operation at a point far to the left of the +120 μa set point. As track speed increases, main generator current decreases and main generator voltage increases. This results in shifting the operating point toward the right.

The pulses at the top of output winding A6 (magsense terminal F), Fig. FS-1, are positive and the pulses at terminal A of A6 are negative when the operating point is to the left of the +120 μa set point. This positive signal at terminal F of A6 is applied through CR2 and R10 to comparator terminal 2. This results in positive saturation at comparator terminal 4. The positive signal at comparator terminal 4 provides forward bias for Q2.

Turn on of Q2 provides a low at the base of Q3. Turn off of Q3 removes forward bias from Q1 and applies forward bias to Q2 of the output stage, Fig. FS-2. Turn on of Q2 in the output stage results in current flow through the diode of opto-isolator OT2 which results in current flow through controlled bias winding A3, R12, OT2, and RH1 in the detector stage. Rheostat RH1 is adjusted so that the pulses at terminal F of output winding A6 switch to negative and the pulses at terminal A of A6 switch to positive when main generator current decreases to about 1075 amperes and main generator voltage increases to about 975 volts as a result of increased track speed.

The positive pulses at terminal A of A6 are applied through CR3 and R14 to comparator terminal 1. This results in positive saturation at comparator terminal 5. The positive signal at comparator terminal 5 is applied through R9 to comparator terminal 3. This results in negative saturation at comparator terminal 4. This negative signal provides reverse bias for Q2.

Turn off of Q2 results in forward bias for Q1 and the diode of opto-isolator OT1 of the output stage and also removes forward bias from Q2 of the output stage, Fig. FS-2. Turn off of Q2 results in turn off of opto-isolator OT2. Current flow through the diode of opto-isolator OT1 results in current flow through controlled bias winding A3, R12, OT1, and RH2 of the detector stage. Turn on of Q1, Fig. FS-2, provides a feed to the FSR relay.

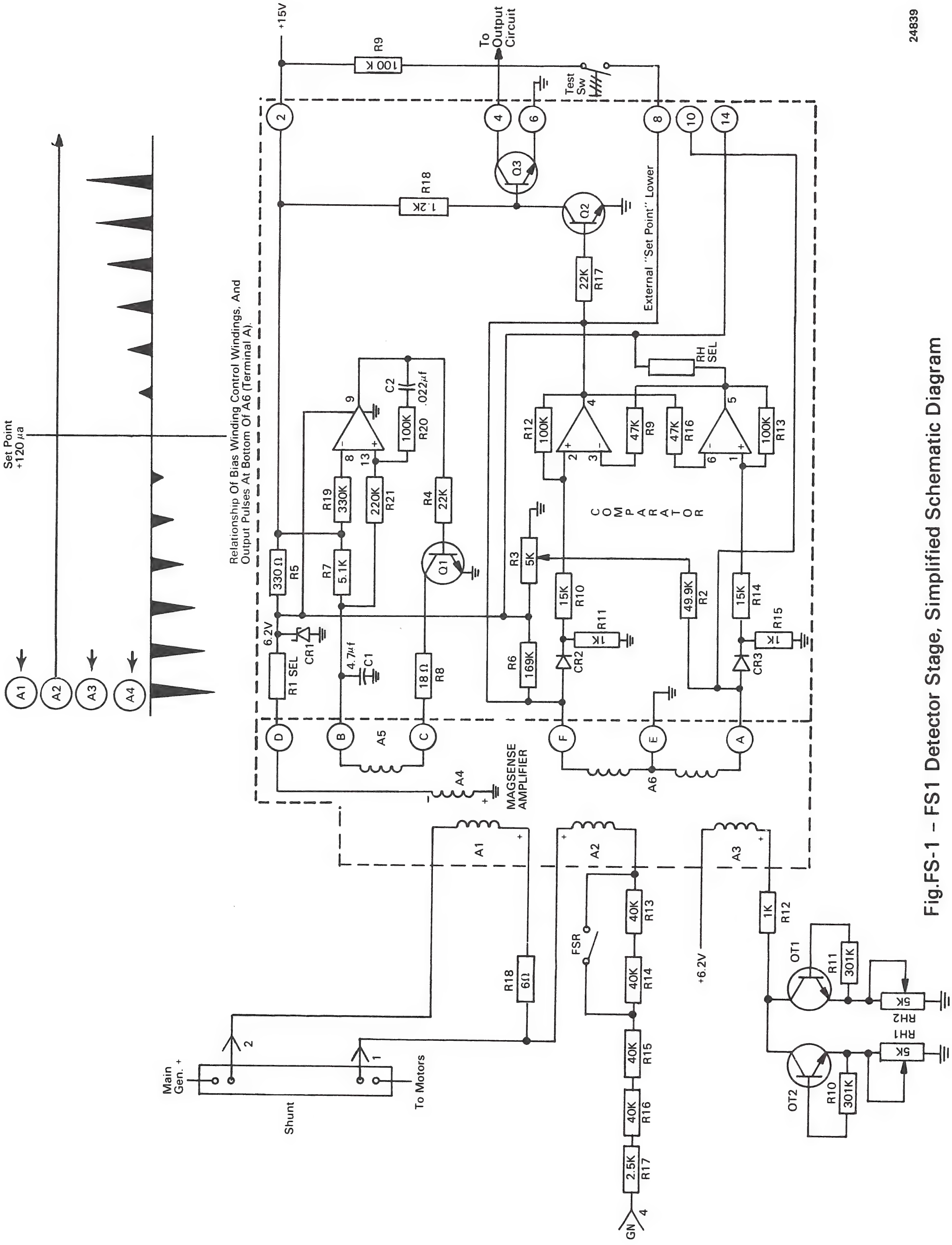

Fig.FS-1 – FS1 Detector Stage, Simplified Schematic Diagram

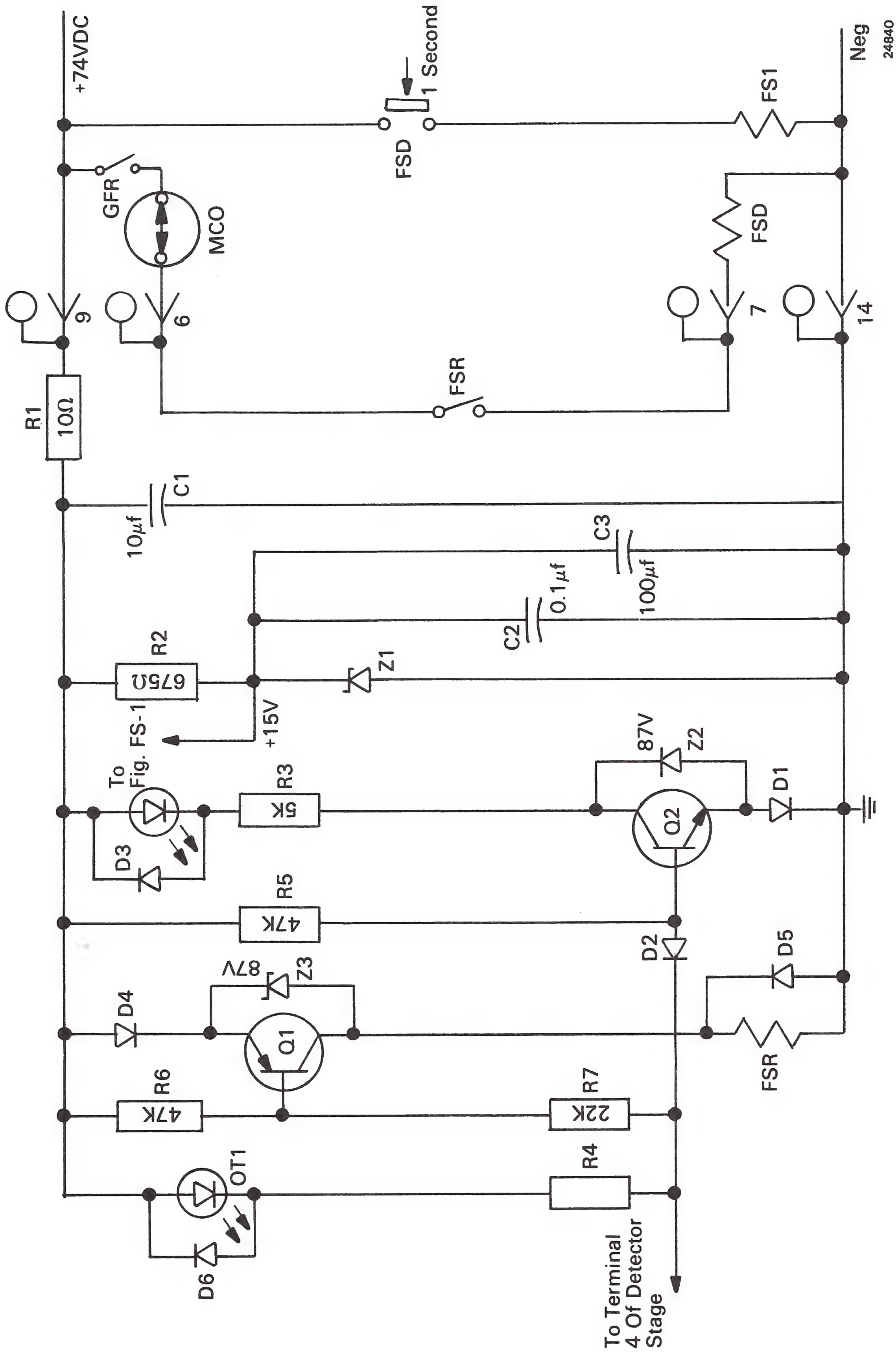

Fig.FS-2 – FS1 Output Stage, Simplified Schematic Diagram

Pick up of FSR provides a feed to the field shunt delay relay FSD. Pick up of FSR also recalibrates the A2 control winding by shorting out R13 and R14 in the detector stage, Fig. FS-1. This recalibration moves the operating point toward the right from the +120 μa set point. Moving the operating point to the right prevents cycling of the FSR relay when operating at a track speed near the FSR relay pick up point.

Pick up of field shunt delay relay FSD provides a feed to field shunt relay FS-1. Pick up of FS1 weakens the traction motor fields by connecting a low resistance shunt across the traction motor fields. The shunt remains across the traction motor fields until track speed decreases so that main generator current increases to about 1720 amperes and main generator voltage decreases to about 610 volts.

TEST

To check FS1 module operation, close and hold the test switch located on the FS1 module faceplate. This provides a path for current flow through R9 and the test switch to terminal 8 of the magsense comparator. From terminal 8, current flows to terminal F of A6 then out terminal E of A6 to common. This current flow from F to E of A6 shifts the operating point to the right of the +120 μa set point and results in positive pulses at terminal A of A6 and negative pulses at F of A6.

The positive pulses at A of A6 is applied through CR3 and R14 to comparator terminal 1. This results in positive saturation at comparator terminal 5 and negative saturation at comparator terminal 4. The negative at terminal 4 provides reverse bias at the base of Q2. Turn off of Q2 provides forward bias for Q3. Turn on of Q3 results in pick up of FSR, FSD, and FS1. Therefore, closing the test switch results in pick up of the field shunting contactors.

Releasing the test switch shifts the operating point back to the left of the +120μa set point resulting in positive pulses at terminal F of A6. This results in turn on of Q2 and drop out of FSR, FSD, and FS1.

LOAD REGULATOR ASSEMBLY

The load regulator assembly LR consisting of a 1500 ohm tapered plate-type rheostat and a hydraulically operated vane motor, receives input signals from the excitation control module EC and provides a reference voltage to a comparison circuit on the EC module. The wiper arm of the load regulator, which may be moved through an arc of 300 degrees, is attached to the vane motor. A pilot valve, located in the engine speed governor, controls the flow of engine oil under pressure to drive the vane motor clockwise or counterclockwise to position the wiper arm. Refer to Fig. LR-l.

The input voltage applied to the load regulator depends upon the throttle setting and the state of charge on the rate control capacitor on the EC module. When operating in throttle positions 5 through 8, and with the rate control capacitor fully charged, the input voltage applied to the load regulator is 37 volts. The input voltage applied to the load regulator decreases as the throttle position is decreased below throttle position 5.

The output voltage available at the load regulator wiper arm depends upon the input voltage applied to the load regulator and the position of the wiper arm. At locomotive standstill and during initial startup, the load regulator is in maximum field position. Output voltage of the load regulator when in maximum field position is approximately equal to input voltage.

During normal operation, with the throttle in a fixed position, the output voltage from the load regulator is determined by the input voltage to the load regulator and main generator current. Assume that the locomotive is operating in throttle 8

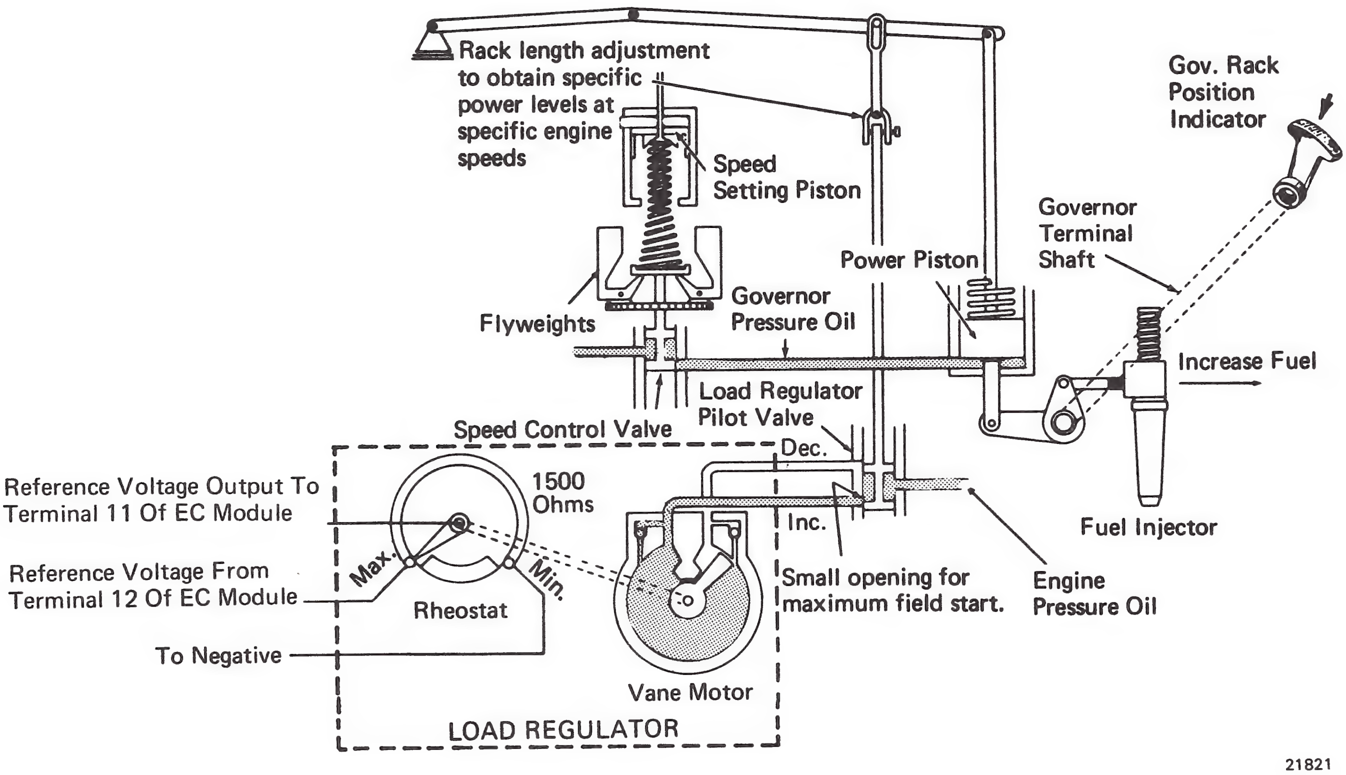

Fig.LR-1 – Load Regulator Simplified Diagram

position with a 30 volt reference signal from LR as shown in Fig. LR-2. If load is increased, such as when starting up a grade, the speed of the traction motors will decrease due to the increased load.

With decrease in traction motor speed, the load current increases due to a decrease in counter electromotive force. An increase in traction motor current results in a decrease in voltage. This decrease in voltage is partly due to the increases I^2R and IZ losses in the main generator. The increase in current strengthens the differential field which opposes the battery field and results in less excitation to the main generator. Battery field excitation must be increased to maintain constant horsepower.

If the reference signal from LR remains at 30 volts, the horsepower applied to the traction motors which follow the 30 volt reference line from point "A" toward point "B" in Fig. LR-2. However, to follow the 30 volt reference line the operating point would fall below the constant horsepower curve and less horsepower would be applied to the traction motors.

The decrease in horsepower tends to cause an increase in diesel engine speed. This increase in speed is sensed by the engine speed governor. The governor reacts to temporarily decrease the amount of fuel injected into the engine and thereby maintains a constant engine speed. At the same time that the fuel is decreased a pilot valve in the engine speed governor directs hydraulic pressure to the load regulator vane motor which causes the load regulator to move toward maximum field position. This action can be followed by referring to Fig. LR-1. The increase in speed causes the governor fly weights to pivot outward which results in raising the speed control valve plunger. This allows some of the oil under the power piston to escape below the lower land on the speed control valve plunger causing the power piston to move downward. The escaped oil returns to the oil sump in the governor. Downward movement of the power piston causes a downward movement of the load regulator pilot valve plunger and also moves the governor rack to decrease the fuel to the engine. Downward movement of the load regulator pilot valve plunger directs engine oil, under pressure, to the increase port of the load regulator vane motor. This causes the vane motor to drive the wiper arm of the load regulator rheostat toward maximum field position.

Movement of the load regulator toward maximum field position results in an increase in the reference signal from LR. Increasing the reference signal results in an increase of excitation to the main generator battery field and an increase in main generator horsepower output. This increased horsepower tends to decrease diesel engine speed, however, the governor again reacts to maintain a constant engine speed. The pilot valve in the governor also causes a slight adjustment in load regulator position so that the main generator output moves along the constant horsepower curve from

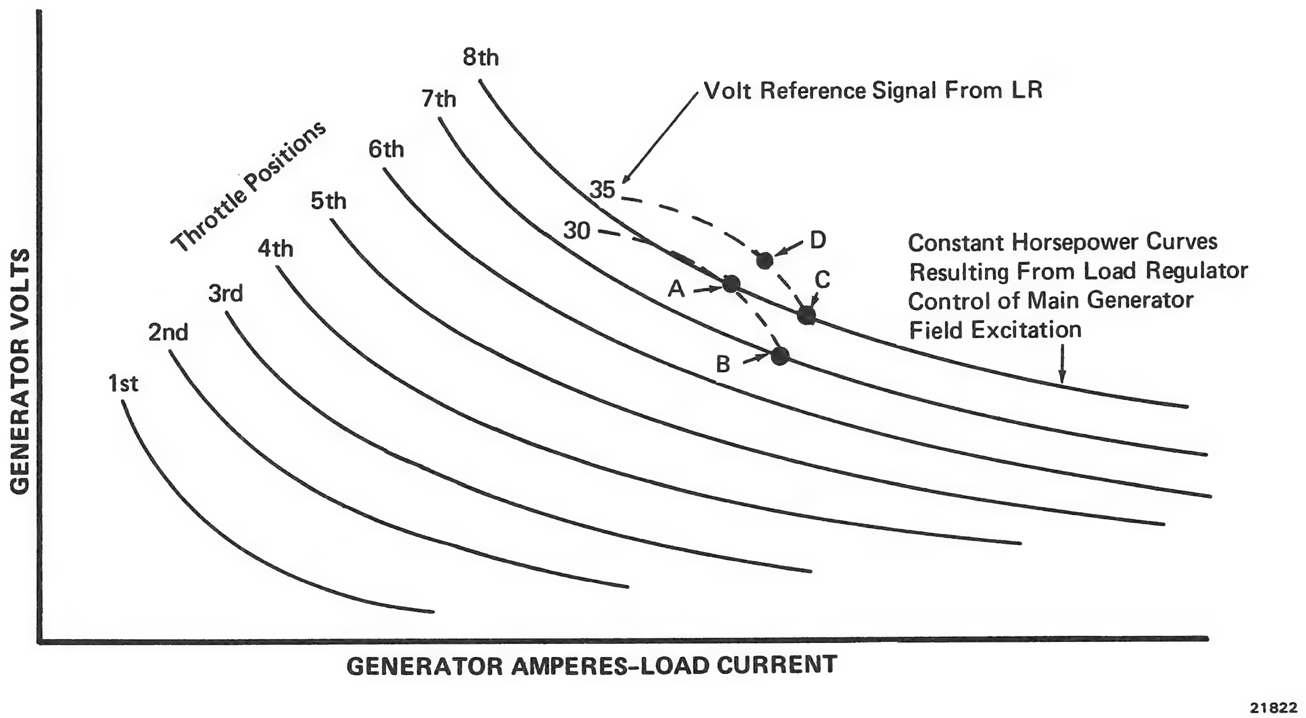

Fig.LR-2 – Constant Kilowatt (Horsepower) Curves – Nominal

point "A" to point "C" instead of from point "A" to point "B" in Fig. LR-2. Refer to Fig. LR-1. The decrease in engine speed causes the governor fly weights to move inward which results in lowering the speed control valve plunger. This allows the governor oil, under pressure, to be forced under the power piston causing the power piston to move upward. Upward movement of the power piston causes an upward movement of the load regulator pilot valve plunger and also moves the governor rack to increase the fuel to the engine. Upward movement of the load regulator pilot valve plunger allows the oil from the increase port to drain into the engine oil sump and also opens the decrease port to engine oil pressure. Oil pressure at the decrease port causes the vane motor to drive the load regulator wiper arm toward minimum field position. Therefore, the engine speed governor maintains a constant engine speed and the load regulator maintains a constant horsepower output within the normal operating range of the locomotive. The response of the engine speed governor and the load regulator is fast enough to prevent any noticeable difference in diesel engine speed or main generator output.

Assume that the locomotive is operating in throttle position 8 with a 35 volt reference signal from LR as shown at point "C" of Fig. LR-2. If load is decreased, such as when starting down a grade, the speed of the traction motors will increase due to the decreased load.

With an increase in traction motor speed, the load current decreases due to an increase in counter electromotive force. A decrease in traction motor current results in an increase in voltage. The decrease in current weakens the differential field which opposes the battery field and results in more excitation to the main generator. Battery field excitation must be decreased to maintain constant horsepower. If the reference signal from LR remained at 35 volts the horsepower applied to the traction motor would follow the 35 volt reference line from point "C" toward point "D" in Fig. LR-2. However, to follow the 35 volt reference line, the operating point would rise above constant horsepower curve and more horsepower would be applied to the traction motors.

The increase in horsepower tends to decrease diesel engine speed. This decrease in speed is sensed by the engine speed governor. The governor reacts to temporarily increase the amount of fuel injected into the engine and thereby maintains a constant engine speed. At the time that the fuel is increased, a pilot valve in the engine speed governor directs hydraulic pressure to the load regulator vane motor which causes the load regulator to move toward minimum field position. Refer to Fig. LR-1. The decrease in speed causes the governor fly weights to move inward which results in lowering the speed control valve plunger. This allows the governor oil, under pressure, to be forced under the power piston causing the power piston to move upward. Upward movement of the power piston causes an upward movement of the load regulator pilot valve plunger and also moves the governor rack to increase the fuel to the engine. Upward movement of the load regulator pilot valve plunger allows the oil from the increase port to drain into the engine oil sump and also opens the decrease port to engine oil pressure. Oil pressure at the decrease port causes the vane motor to drive the load regulator wiper arm toward minimum field position.

Movement of the load regulator toward minimum field position results in a decrease in the reference signal from LR. Decreasing the reference signal results in a decrease of excitation to the main generator field and a decrease in main generator output. This decreased horsepower tends to increase diesel engine speed, however, the governor again reacts to maintain a constant engine speed. The pilot valve in the engine speed governor also causes a slight adjustment in load regulator position so that the main generator output moves along the constant horsepower curve from point "C" to point "A" instead of moving from point "C" to point "D" in Fig. LR-2.

The load regulator operation described above tends to cause the locomotive to operate along the horsepower curves shown in Fig. LR-2. Notice that a different horsepower curve is provided for each throttle position. The horsepower curves shown in Fig. LR-2 are general horsepower curves and do not indicate specific values of main generator current or voltage.

SERVICE SELECTOR SWITCH

The MP15DC locomotive is equipped with a four position Service Selector Switch SSS. This rotary snap switch is provided to select the type of locomotive service desired. The four positions are SWITCHING 1, SWITCHING 2, SERIES (FORESTALLING), and ROAD (AUTO). Nominal engine speeds from idle through throttle position 8 are provided in Fig. SSS-1. The following paragraphs provide a description of the various positions of SSS.

NOTE

The maximum continuous current rating of the traction motors and the value given on the traction motor short time rating plate is applicable only when operating at throttle No. 8 engine speed. These values decrease as engine speed is reduced and cooling air is decreased.

To reduce the possibility of motor damage due to high motor current and low cooling during low throttle operation, SWITCHING 1 and SWITCHING 2 positions should not be used for drag service.

SWITCHING 1 Position

This is the normal position for yard switching. It should be used only when kicking empty or light cars. The load regulator is in maximum field position at locomotive start and the generator excitation circuit is set up to provide fast but controlled throttle response for switching operations.

SWITCHING 2 Position

Locomotive operation in the SWITCHING 2 position is the same as in SWITCHING 1 position except that the engine idles faster in SWITCHING 2 position. The faster idle results in faster acceleration. This position may be used when fast acceleration is desired, such as for "kicking" cars.

SERIES (FORESTALLING) Position

This switch position is included with the MP15DC locomotive even through the motors are connected in permanent series-parallel with main generator. The reason being that switchers with transition

Throttle Position	Service Selector Switch Position And Engine RPM			
	Switching 1 RPM	Switching 2 RPM	Series Forestalling RPM	Road Auto RPM
1	318 ± 4	517 ± 15	318 ± 4	318 ± 4
2	366 ± 15	517 ± 15	366 ± 15	366 ± 15
3	517 ± 15	517 ± 15	517 ± 15	517 ± 15
4	570 ± 4	570 ± 4	570 ± 4	570 ± 4
5	676 ± 15	676 ± 15	676 ± 15	676 ± 15
6	730 ± 4	730 ± 4	730 ± 4	730 ± 4
7	848 ± 15	848 ± 15	848 ± 15	848 ± 15
8	904 ± 4	904 ± 4	904 ± 4	904 ± 4

24841

Fig.SSS-1 – Throttle Positions And Engine RPM For Different Modes Of Operation

circuits may operate in multiple with the MP15DC. In such case, the SERIES Position is used in slow speed, heavy drag service where transition speed is reached so infrequently that changes in motor connections are not desirable.

With the service selector switch in SERIES position, the load regulator is in minimum field position at locomotive start. Throttle response limiting resistance in the generator field excitation circuit is modulated by the load regulator. This provides smooth application of power for a softer start in road service. If MP15DC locomotives are operating in consist or independently, the SERIES and the ROAD positions have the same effect.

ROAD (AUTO) Position

The ROAD (AUTO) position is used during moderate and high speed road operation. At locomotive start the load regulator is in minimum field position and throttle response limiting resistance in the generator field excitation circuit is modulated by the load regulator to provide a softer start in road service. If the MP15DC is operating in multiple with units that are equipped to make transistion, it allows for a change from series to series-parallel on trailing units.

WHEEL SLIP DETECTION AND CONTROL SYSTEMS

INTRODUCTION

The wheel slip system helps to maintain wheel traction under adverse operating conditions and provides protection for the traction motors by detecting and correcting wheel slip conditions before the slip is severe enough to damage the traction motors.

Two types of wheel slip conditions that may be encountered are simultaneous wheel slip and differential wheel slip. Simultaneous wheel slip is a condition where wheel slip occurs at the same rate on all wheels of the locomotive. Differential wheel slip is a condition where one pair of wheels slip at a different rate than the other wheels on the locomotive.

Wheel slip detection is accomplished either by a through-cable balanced armature relay, Fig. 7C-1, or by voltage sensitive relays that are connected in bridge circuits with traction motor armatures and fixed resistors.

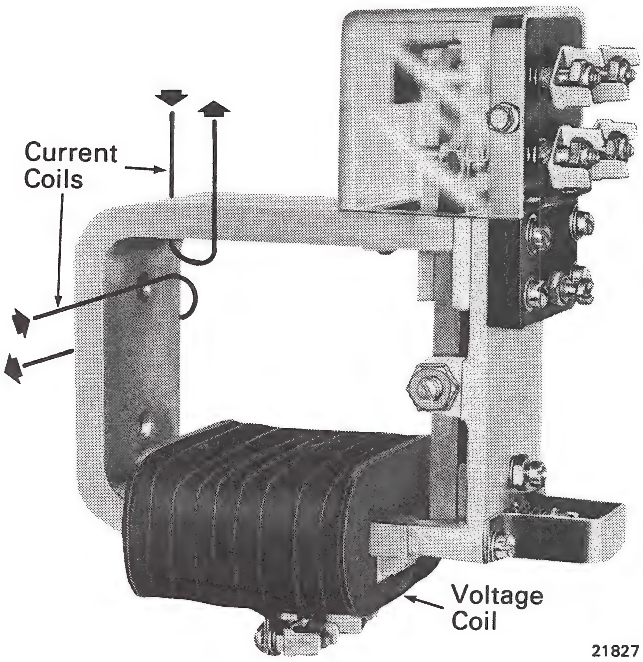

Fig.7C-1 - Through-Cable Wheel Slip Relay

Wheel slip correction is accomplished when relay contacts operate to reduce total locomotive power until adhesion at the wheels is regained. Power is reduced by dropping out the main generator battery field contactor. On special request by the railroad, sand can be applied automatically at the wheels when slip is detected.

During normal operation, the armature current is approximately equal for all traction motors and a balanced condition exists. However, during a differential wheel slip condition, armature current through the motors is unequal and an unbalanced condition exists. The through-cable relays are connected so that any unbalance in traction motor current is detected. This unbalanced condition results in pickup of the through-cable relays. Pickup of any one of the relays initiates corrective action for the wheel slip condition.

THROUGH-CABLE DETECTION

Cables from two pairs of traction motor circuits pass through the frame of the relay, Fig. 7C-2. During normal operation, motor currents are equal and the resulting magnetic flux is nullified. When a wheel slips under power, current in the affected motor circuit is reduced. The resulting current differential causes the balanced armature to operate relay contacts which act to reduce power.

BRIDGE CIRCUIT DETECTION

Bridge circuits pairing the Nos. 1 and 2 and the Nos. 3 and 4 motors are shown in Fig. 7C-3.

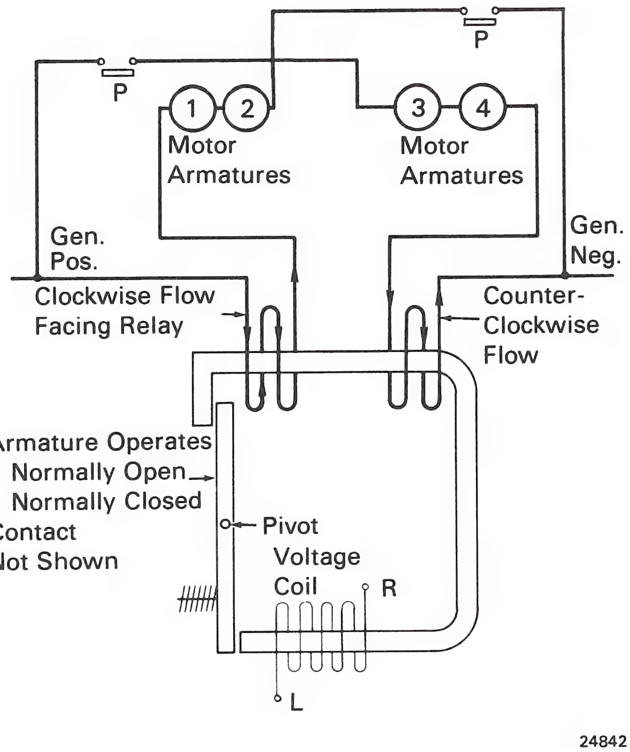

Fig.7C-2 – General Circuit Diagram Of Through-Cable Relay

During normal operation, voltages at the bridge are in balance and no current flows through the relay coil. When a wheel slip occurs, the affected motor armature rotates faster. Voltage across the motor increases to unbalance the bridge, and current flows in the relay coil. Relay contacts open the feed to the BF contactor coil. The FV contactor drops out to remove main generator excitation and correct the wheel slip.

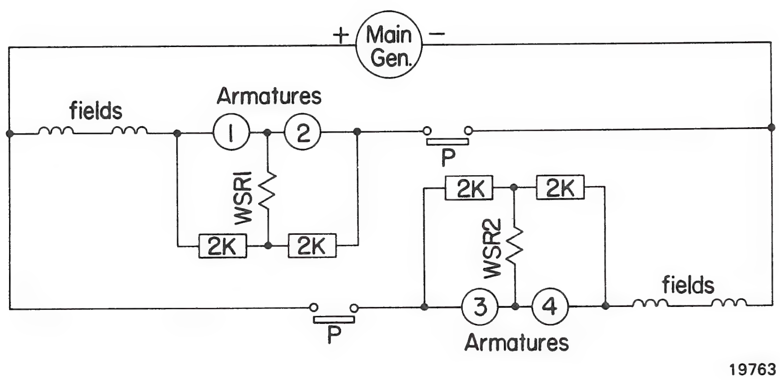

Fig.7C-3 – Wheel Slip Bridge Circuit, Simplified Diagram

SECTION

8

ELECTRO-MOTIVE

LOCOMOTIVE SERVICE MANUAL

INSPECTION AND REPLACEMENT OF CONTACT TIPS FOR CONTACTORS AND TRANSFER SWITCHES

MAINTENANCE OF CONTACT TIPS — GENERAL

Only skilled personnel, familiar with electrical equipment and the hazards involved, should be permitted to service contactors and transfer switches. All safety precautions must be observed.

Minimum maintenance is required to keep the switchgear in serviceable condition. Moving mechanical parts should be free from excess friction, and should be checked for excessive wear. The bearing surfaces are designed to operate without lubrication. Do *not* oil or grease at any time.

Main contact and arc chute parts are normally oxidized and smoked from regular service. Other parts should not show visible damage from high temperatures.

Contact tips used on all EMD switchgear are made of alloy material. The contacting surfaces of these alloy tips take on irregularities during the first few operating cycles. It is during this initial operation that the majority of contact wear occurs. The discoloration on the surfaces of the contact tips, which results from repeated cycling, does not affect contact operation.

ALLOY CONTACTS WILL OPERATE SATISFACTORILY EVEN THOUGH BLACKENED, PITTED, AND ERODED. DO NOT CLEAN, DRESS, OR FILE CONTACT SURFACES. REPLACE CONTACTS WHEN ANY PORTION OF THE ALLOY MATERIAL IS WORN TO THE BASE METAL.

The contactor must be kept clean, connections tight, and should be inspected and serviced at intervals as specified in the Scheduled Maintenance Program.

SAFETY PRECAUTIONS

The following safety considerations should always be carefully observed in the application, operation, and servicing of the equipment.

1. ELECTRICAL RATINGS of the equipment are values that should be considered to be EXTREMELY DANGEROUS to personnel.

2. EQUIPMENT SHOULD ALWAYS BE COMPLETELY DE-ENERGIZED BEFORE HANDLING OR PERFORMING ANY SERVICE OPERATIONS. De-energizing the operating coil is not sufficient to render the equipment safe. The power lines must also be disconnected or otherwise de-energized. If power lines are not de-energized, all parts of the device should be considered to be at the maximum system voltage.

3. IF INSPECTION OF ENERGIZED EQUIPMENT IS NECESSARY, DO NOT TOUCH OR HANDLE ANY PARTS. DO NOT STAND IN FRONT OF THE EQUIPMENT OR AT CLOSE RANGE TO PERFORM VISUAL INSPECTIONS. The discharge of hot gases and particles is always likely when the contactor is operated in an energized circuit.

4. NEVER ATTEMPT TO OPERATE THE POWER CONTACTOR WITHOUT HAVING THE ARC CHUTE PROPERLY IN PLACE.

5. NEVER ATTEMPT TO REMOVE THE ARC CHUTE WHILE THE POWER CONTACTOR IS IN AN ENERGIZED OR CLOSED POSITION. Such action is extremely dangerous and would likely result in extensive damage.

6. Operating temperatures for the power contactor are high. Some parts of these devices may

normally reach temperatures in excess of 200° F. SERIOUS BURNS CAN RESULT FROM HANDLING THE EQUIPMENT AFTER IT HAS BEEN IN SERVICE, AND BEFORE IT HAS BEEN ALLOWED TO COOL.

INSPECTION AND REPLACEMENT OF POWER CONTACTOR CONTACTS

INSPECTION OF MAIN CONTACTS

1. Pull arc chute assembly latch spring, Fig. 8-1, forward and remove arc chute assembly by lifting front end of arc chute away from main body of contactor.

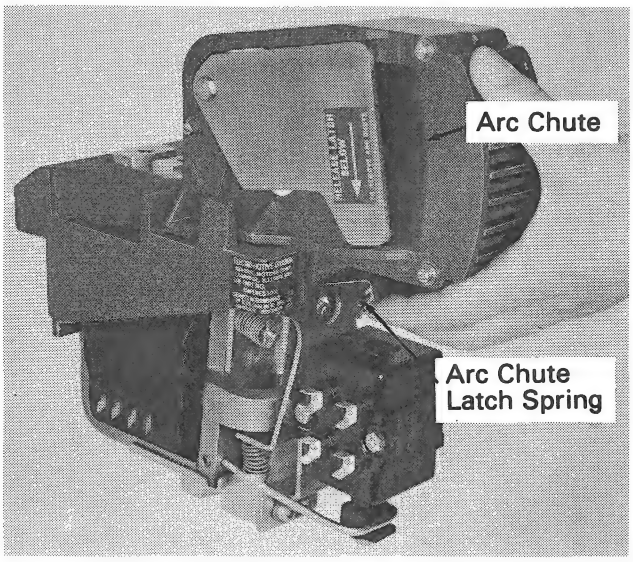

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Fig.8-1 - Power Contactor

2. Inspect the two stationary contact tips and the movable contact tip. Refer to Fig. 8-2 to determine if contacts are usable or require replacement. If one is eroded beyond wear limits of Fig. 8-2, replace stationary contact tips and movable contact tip.

REMOVAL OF MOVABLE ARC TIP ASSEMBLY

NOTE

If arc chute assembly has not been removed for inspection, remove per Step 1 of "Inspection Of Contacts."

1. Remove screw and lockwasher, Fig. 8-3, holding the movable arc tip assembly to the movable contact assembly.

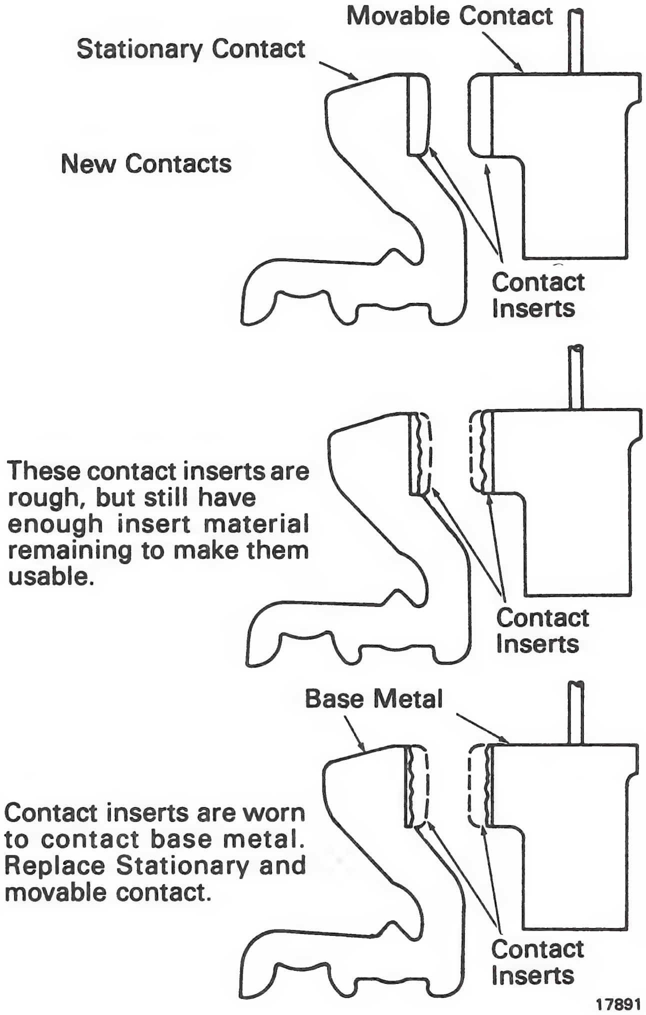

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Fig.8-2 - Contact Wear Limits

2. Remove arc tip from slot between movable contact support and the hold-on magnet bracket by pulling up on the movable arc tip, while moving the movable arc tip slightly from side to side.

REPLACEMENT OF MOVABLE CONTACT ASSEMBLY

1. Remove two screws and lockwashers, Fig. 8-4, holding movable contact assembly in place. Remove movable contact assembly and replace with a new contact assembly. Secure new contact assembly with screws and lockwashers, but do not tighten screws at this time.

2. Ensure that the movable contact assembly is properly seated, then tighten screws. Recheck seating of the contact after screws are tightened.

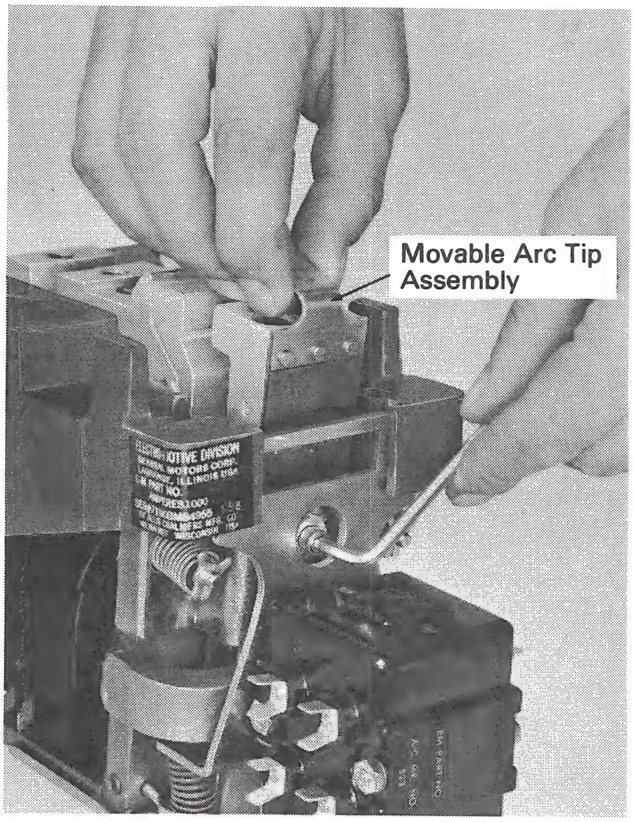

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Fig.8-3 – Removal Of Movable Arc Tip Assembly

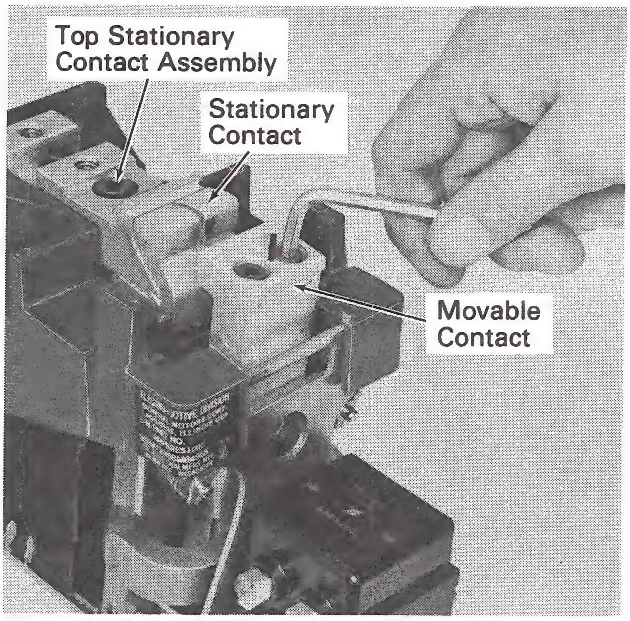

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Fig.8-4 – Removing Movable Contact Assembly

REPLACEMENT OF MOVABLE ARC TIP ASSEMBLY

1. Insert new movable arc tip assembly into slot between movable contact support and the hold-on magnet bracket.

CAUTION

Arc tip assembly must be inserted *between* the hold-on magnet bracket and the movable contact support, *not* in front of the hold-on magnet bracket.

2. Align the hole in the movable are tip assembly and the hole in the movable contact support with the hole in the hold-on magnet bracket. Insert screw and tighten securely.

REPLACEMENT OF STATIONARY ARC TIP ASSEMBLY

The stationary arc tip assembly is located in the arc chute assembly.

1. Remove two screws and lockwashers holding the stationary arc tip assembly to the arc chute, Fig. 8-5.

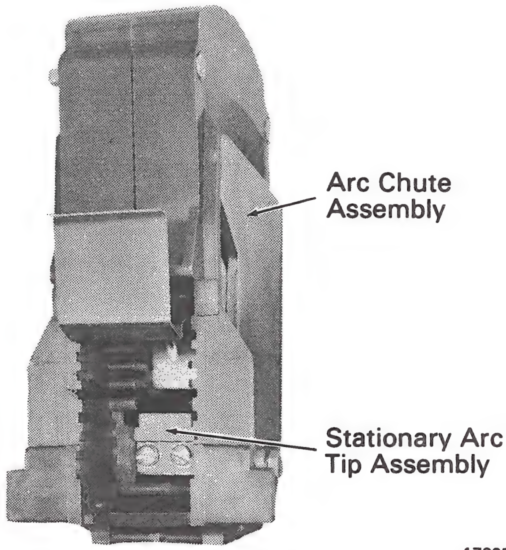

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Fig.8-5 – Replacement Of Stationary Arc Tip Assembly

2. Lift out stationary arc tip assembly.

3. Place a new stationary arc tip in proper position and install two screws and lockwashers. Tighten screws securely.

REPLACEMENT OF STATIONARY CONTACT ASSEMBLIES

1. Remove the top stationary contact assembly and two stationary contacts and spacer by removing two screws and lockwashers, Fig. 8-4.

2. Position spacer on the top terminal molding, with the short leg of the "L" down between the

pivot springs and the long leg extending back between the wipe springs.

3. Place new stationary contacts over wipe springs and pivot springs. Be certain that the spring caps are firmly seated on pivot springs.

4. Insert pointed nose of the top stationary contact assembly into the cavity in back of the stationary contact, engaging the mating pivots.

5. With pivots engaged and the top stationary contact assembly held back against the stop in the top terminal molding, secure with two screws and lockwashers.

6. Check for freedom of movement of both stationary contact assemblies. Refer to Service Data for contact gap.

INSPECTION OF INTERLOCK CONTACTS

1. Remove screw (3, Fig. 8-6), lockwasher, and washer from bottom of interlock assembly (1), and remove interlock operator (2).

2. Remove two screws (9) from interlock assembly (1), and carefully remove the left-hand cover, exposing interlock contacts. Interlock contacts do not require replacement until they are worn 1.53 mm (0.060") per mating pair, when compared to new contact dimensions. Refer to Fig. 8-7, to determine if contacts are usable or require replacement.

NOTE

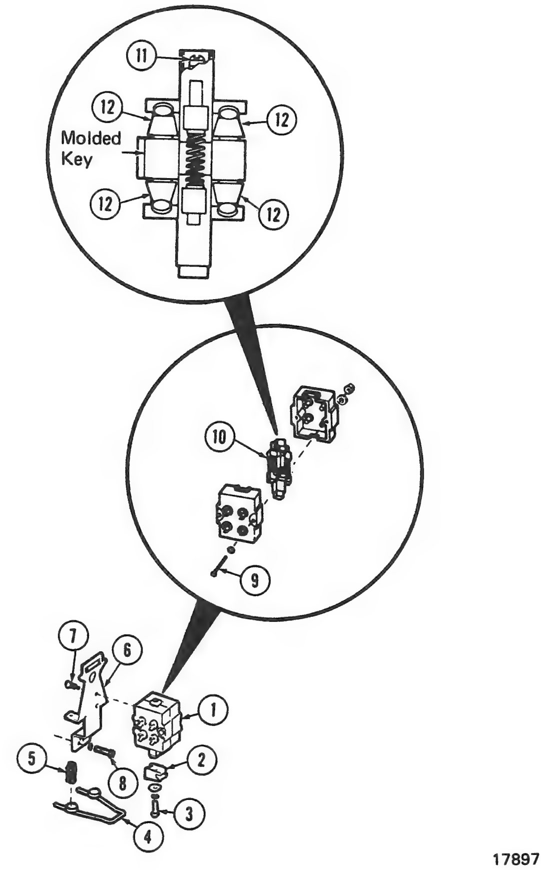
If the contacts in the movable contact carrier are worn beyond the limits in Fig. 8-7, the contact bridges should be replaced. If the stationary contacts are defective or loose, the interlock assembly should be replaced.

REPLACEMENT OF INTERLOCK ASSEMBLY

If inspection determined that interlock assembly should be replaced, proceed as follows:

1. Remove return springs (5, Fig. 8-6), with screw driver.

2. Remove two screws (8) from bottom terminal assembly and swing the interlock support bracket (6), with interlock assembly attached, forward until disengaged from top terminal molding.



1. Interlock Assembly
2. Interlock Operator
3. Screw
4. Operating Lever
5. Return Spring
6. Support Bracket
7. Screw
8. Screw
9. Screw
10. Contact Carrier
11. Screw
12. Contact Bridge

Fig.8-6 - Interlock Assembly, Partially Exploded

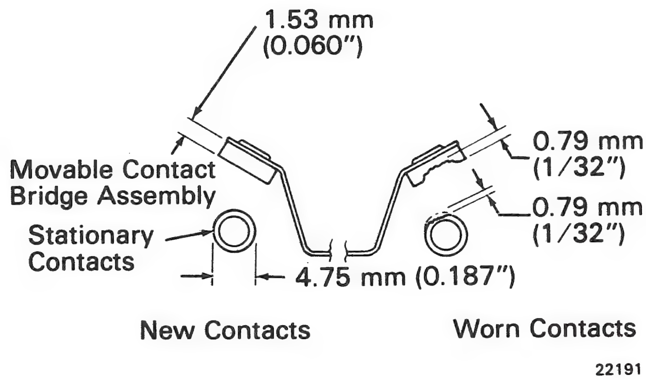


Fig.8-7 - Interlock Contact Wear Limits

3. Remove two screws (7) and remove interlock assembly from support bracket.

4. Mount new interlock assembly to support bracket with screws.

5. Position top end of interlock support bracket under front end of top terminal molding.

6. Attach interlock support bracket (6) loosely to bottom terminal assembly with two screws (8) and lockwashers. Center bracket in the opening of top terminal molding, and tighten screws.

7. Insert both return springs (5) between cups on operating lever (4) and spring location buttons on return spring bracket. Springs must be fully seated in cups.

8. Attach interlock operator (2) to bottom of contact carrier (10) with screw, Belleville washer, and lockwasher.

REPLACEMENT OF INTERLOCK CONTACTS

If inspection determined that interlock contacts should be replaced, proceed as follows:

1. Remove contact carrier (10, Fig. 8-6), from interlock assembly cover half.

NOTE

Work on contact carrier in an area where small parts will not be lost if dropped.

2. Hold contact carrier in palm of hand and loosen screw (11) so that the top, center, and bottom elements of the carrier can be separated sufficiently to remove an upper and lower set of contact bridges (12).

3. Insert a new set of upper and lower contact bridges.

CAUTION

Each contact bridge must be positioned properly and *not* inverted since this could cause malfunction of the contactor. See Fig. 8-6 for correct position of contact bridges.

4. Turn over contact carrier in palm of hand and repeat Steps 2 and 3 for remaining two contact bridges, and tighten screw (11). Brass sleeves on all four contact bridge assemblies must be free after screw is tightened.

5. Place contact carrier (10) into the interlock cover half remaining on contactor. Ensure that screw (11) in the carrier is at the end of the interlock cover stamped C-D, and that molded key is outside the cover. Move contact carrier from end to end to ascertain that the contact bridge assemblies are correctly related to the stationary contacts within the covers.

6. Apply other cover half to the interlock assembly.

INSPECTION AND REPLACEMENT OF TRANSFER SWITCH CONTACTS

INSPECTION OF CONTACTS

1. Remove top covers by pushing one end of each cover out of slot in top contact assembly, and lift off.

2. Inspect the eight stationary contact assemblies, Fig. 8-8. Refer to Fig. 8-9, to determine if contacts are usable or require replacement. If one is eroded beyond wear limits shown in Fig. 8-9, replace stationary contact and the mating movable contact.

REPLACEMENT OF STATIONARY CONTACTS

1. Remove return spring, Fig. 8-8.

2. Remove the top stationary contact assemblies, stationary contacts, and spacers by removing the retaining screws and lockwashers.

3. Ensure that support areas for springs are free of all foreign particles.

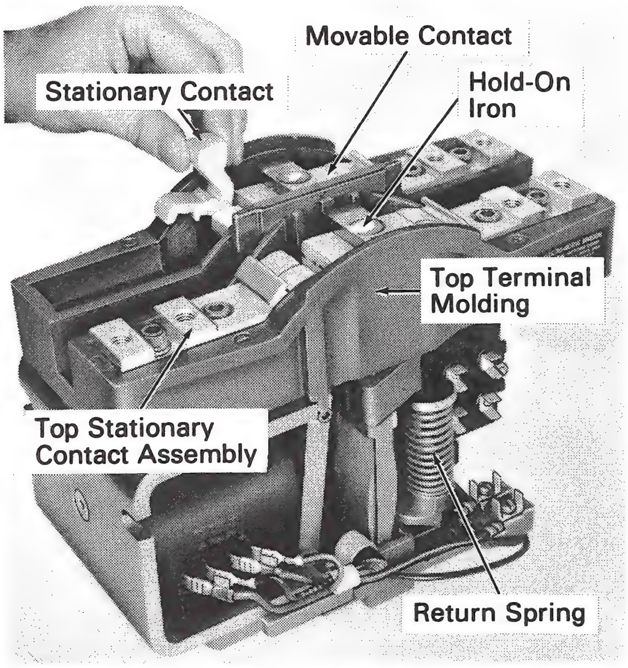
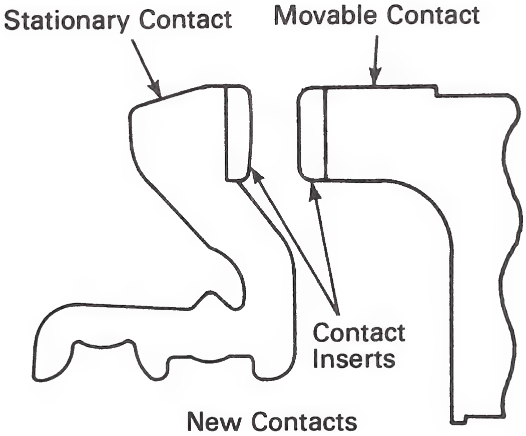
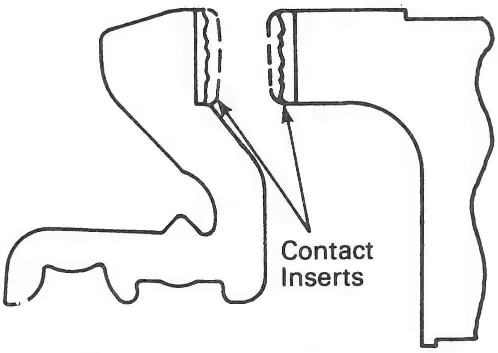
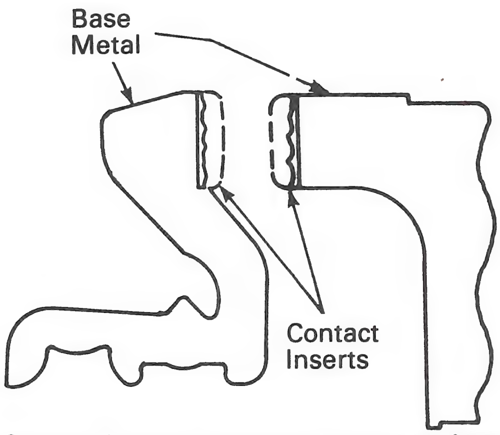


Fig.8-8 – Removing Stationary Contact





These contact inserts are rough, but still have enough insert material remaining to make them usable.



Contact inserts are worn to contact base metal. Replace stationary and movable contacts.

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Fig.8-9 - Main Contact Wear Limits

4. Position spacer on the top terminal molding, with the short leg of the "L" down between the pivot springs and the long leg extending back between the wipe springs.

5. Place new stationary contacts over wipe springs and pivot springs. Be certain that the spring caps are firmly seated on pivot springs.

6. Insert pointed nose of the top stationary contact assembly into the cavity in back of the stationary contact, engaging the mating pivots.

7. With the pivots engaged, and the top stationary contact assembly held back against the stop in the top terminal molding, secure with two screws and lockwashers.

8. Check for freedom of movement of both stationary contacts. Refer to Service Data for contact gap.

REPLACEMENT OF MOVABLE CONTACTS

1. Remove return springs, Fig. 8-8.

2. Remove sealant from heads of screws securing hold-on iron, and remove screws, lockwashers, hold-on iron, and movable contact.

3. Position new movable contact and hold-on iron over movable contact support assembly and secure with screw and lockwasher.

4. Replace return springs.

INSPECTION OF INTERLOCK CONTACTS

1. Remove return springs.

NOTE

On transfer switches with motor cutout, remove two screws and motor cutout, Fig. 8-10.

2. Remove two screws (7, Fig. 8-11) from interlock assembly and carefully remove the left-hand cover exposing interlock contacts. Interlock contacts do not require replacement until they are worn to 1.53 mm (0.060″) per mating pair, when compared to new contact dimensions. Refer to Fig. 8-12 to determine if contacts are usable or require replacement.

NOTE

If the contacts in the contact carrier are worn beyond the limits shown in Fig. 8-12, the contact bridges should be replaced. If the stationary contacts are defective or loose, the interlock assembly should be replaced.

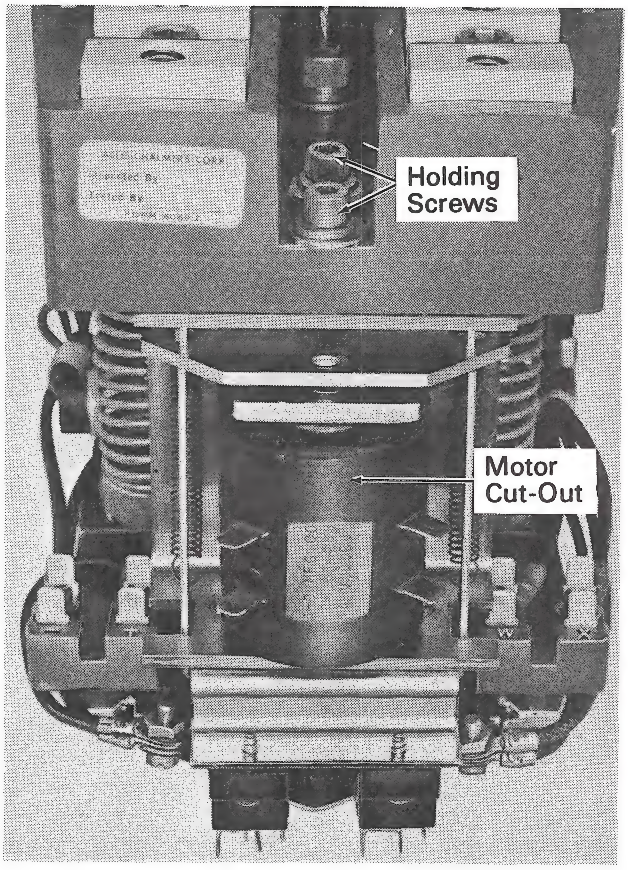

Fig.8-10 – Transfer Switch With Motor Cut-Out

REPLACEMENT OF INTERLOCK ASSEMBLY

If inspection determined that interlock assembly should be replaced, proceed as follows:

1. Remove return springs.
2. Remove screw (3, Fig. 8-11) and interlock operator (2).
3. Remove two screws (6) to separate top return spring bracket (5), support bracket (4), and interlock assembly (1).
4. Attach new interlock assembly to support bracket and top return spring bracket with screws and lockwashers.
5. Position interlock operator (2) on interlock assembly and secure with screw, lockwasher, and Belleville washer.

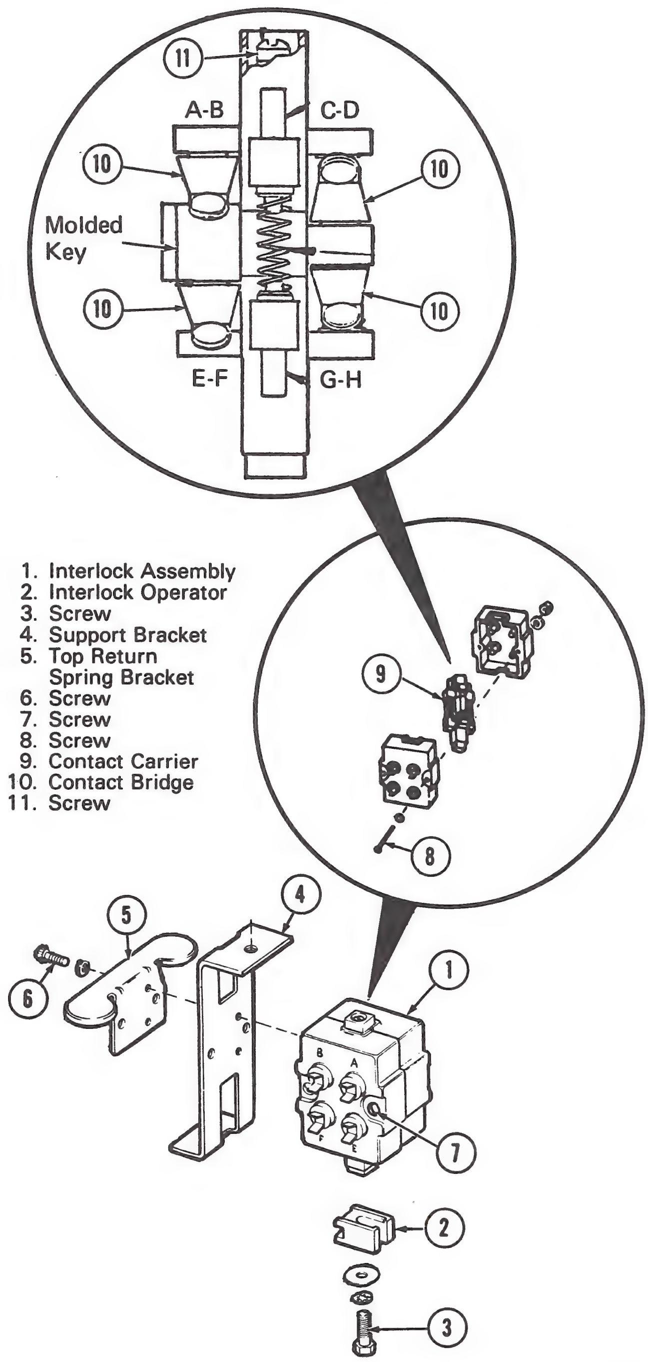

Fig.8-11 – Interlock Assembly, Partially Exploded

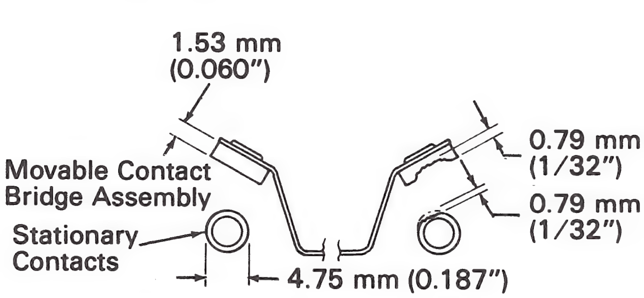

Fig.8-12 – Interlock Contact Wear Limits

REPLACEMENT OF INTERLOCK CONTACTS

If inspection determined that interlock contacts should be replaced, proceed as follows:

1. Remove contact carrier (9, Fig. 8-11) from interlock assembly cover half.

NOTE
Work on contact carrier in an area where small parts will not be lost if dropped.

2. Hold contact carrier in palm of hand and loosen screw (11) so that the top, center, and bottom elements of the carrier can be separated sufficiently to remove an upper and lower set of contact bridges (10).

3. Insert a new set of upper and lower contact bridges.

CAUTION
Each contact bridge must be positioned properly and *not* inverted since this could cause malfunction of the contactor. See Fig. 8-11 for correct position of contact bridges.

4. Turn over contact carrier in palm of hand and repeat Steps 2 and 3 for remaining two contact bridges, and tighten screw (11). Brass sleeves on all four contact bridge assemblies must be free after screw is tightened.

5. Place contact carrier into interlock cover half remaining on the contactor. Ensure that screw (11) in the carrier is at the end of the interlock cover stamped C-D, and that molded key is outside the cover. Move contact carrier from end to end to ascertain that the contact bridge assemblies are correctly related to the stationary contacts within the covers.

6. Apply other cover half to the interlock assembly.

INSPECTION AND REPLACEMENT OF FIELD SHUNTING CONTACTOR CONTACTS

INSPECTION OF CONTACTS

1. Remove molded angle cover to expose contacts.

2. Check stationary and movable contacts. If wear exceeds a total of 1.6 mm (1/16"), replace both contacts.

REPLACEMENT OF MOVABLE CONTACT

1. Remove contact spring from between the movable contact and the operating lever. A screwdriver may be used to compress the spring.

2. Remove capscrew, Fig. 8-13, holding movable contact assembly to the lower stationary contact block.

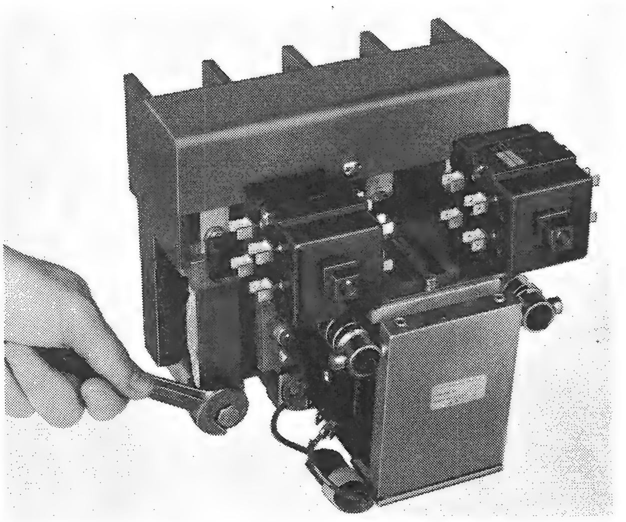

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Fig.8-13 – Removing Movable Contact

3. Pry the U-clamp from the lower stationary contact block. The U-clamp will be removed with the movable contact assembly.

4. Remove movable contact assembly and U-clamp through bottom of contactor.

5. Reapply the U-clamp to the new movable contact assembly, install assembly, and secure with capscrew.

6. Align movable contact to mate with the stationary contact. Ensure contact does not rub or bind in the contactor.

REPLACEMENT OF STATIONARY CONTACT

1. Remove screw and lockwasher holding stationary contact, Fig. 8-14, and remove contact.

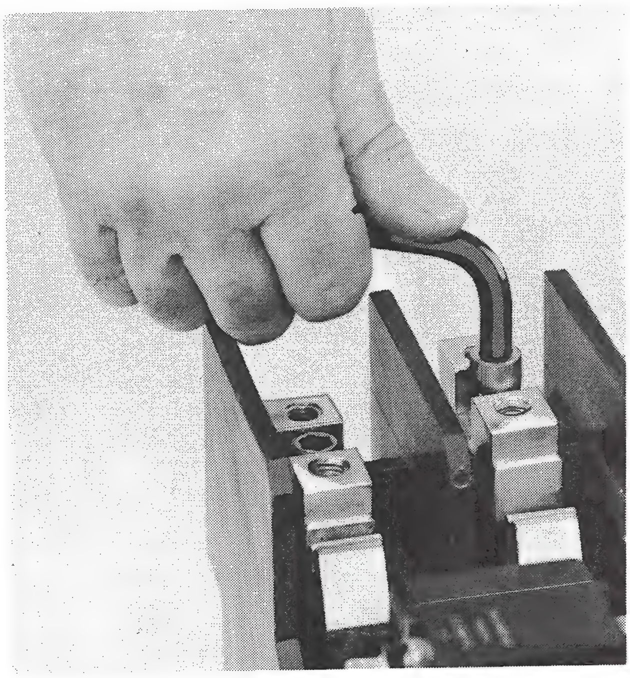

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Fig.8-14 - Stationary Contact Renewal

2. Install new stationary contact and loosely attach with screw and lockwasher. Do not tighten screw at this time.

3. Ensure stationary contact assembly is properly seated and aligned with the movable contact assembly, then tighten screw.

4. Replace the molded angle cover.

INSPECTION OF INTERLOCK CONTACTS

1. Remove two screws, Fig. 8-15, from interlock assembly and carefully remove the left-hand cover, exposing interlock contacts. Interlock contacts do not require replacement until they are worn 1.6 mm (1/16") per mating pair, when compared to new dimensions. Refer to Fig. 8-16 to determine if contacts are usable or require replacement.

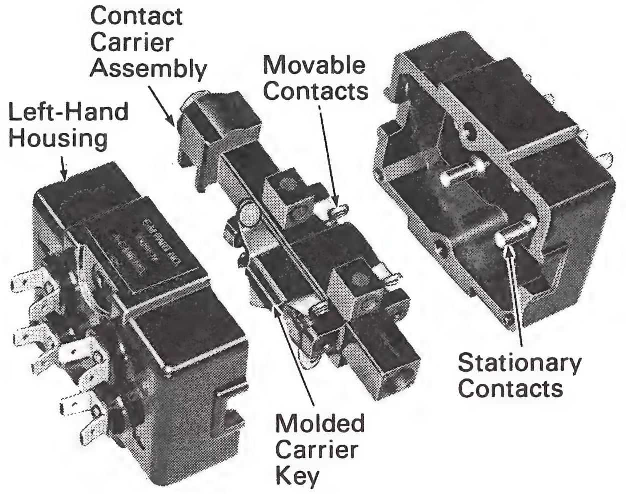

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Fig.8-15 – Auxiliary Interlock Contact Inspection

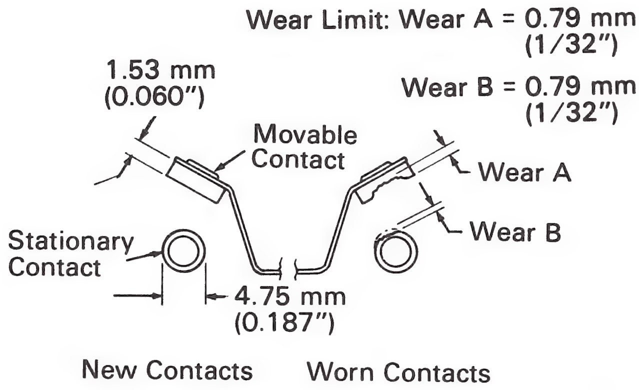

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Fig.8-16 – Interlock Contact Wear Limits

2. If the contacts in the contact carrier are worn beyond the limits shown in Fig. 8-16, the contact bridges should be replaced. If the stationary contacts are defective or loose, the interlock assembly should be replaced.

NOTE

If the field shunting contactor has two interlock assemblies, repeat inspection and replacement procedures for second interlock assembly.

REPLACEMENT OF INTERLOCK ASSEMBLY

1. Remove screw and interlock operator, Fig. 8-15, from interlock assembly.

2. Remove two mounting screws from support bracket, and remove interlock assembly.

3. Attach new interlock assembly to support bracket and reapply interlock operator.

REPLACEMENT OF INTERLOCK CONTACTS

1. Remove contact carrier, Fig. 8-17, from interlock assembly cover half.

NOTE

Work on contact carrier in an area where small parts will not be lost if dropped.

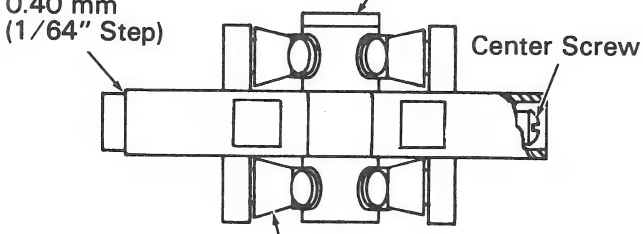


Fig.8-17 – Typical Interlock Contact Carrier Assembly

2. Hold contact carrier in palm of hand and loosen screw so that top, center, and bottom elements of the carrier can be separated sufficiently to remove an upper and lower set of contact bridges.

3. Insert a new set of upper and lower contact bridges.

CAUTION

Each contact bridge must be positioned properly and *not* inverted since this could cause malfunction of the contactor. See Fig. 8-17 for correct position of contact bridges.

4. Turn over contact carrier in palm of hand and repeat Steps 2 and 3 for remaining two contact bridges, and tighten screw. Brass sleeves on all four contact bridge assemblies must be free after screw is tightened.

5. Place contact carrier into interlock cover half remaining on the contactor. Ensure the screw in the carrier is at the end of the interlock cover stamped E-F, and that molded key is outside the cover. Move contact carrier from end to end to ascertain that the contact bridge assemblies are correctly related to the stationary contacts within the covers.

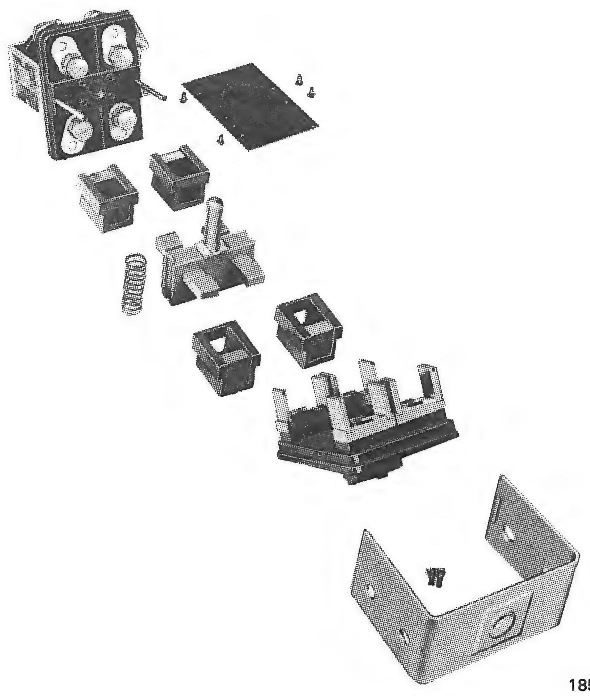
6. Apply other cover half to the interlock assembly.

INSPECTION AND REPLACEMENT OF STARTING CONTACTOR CONTACTS

INSPECTION OF CONTACTS

1. Remove the front cover (8, Fig. 8-18), and the four screws holding the rear cover plate (3) to the lower contact base (7).

2. Check stationary (1) and movable contacts (5). If movable contacts are worn where 0.79 mm (1/32") or less alloy material remains, the contacts should be replaced.



1. Stationary Contact
2. Guide Spacer
3. Rear Cover Plate
4. Plunger Assembly
5. Movable Contact
6. Arc Box
7. Lower Contact Base
8. Front Cover
9. Main Spring
10. Upper Contact Base
11. Magnet Coil Assembly

Fig.8-18 – Top-Mounted Coil, Lower Contact Assembly, Exploded View

REPLACEMENT OF MOVABLE AND STATIONARY CONTACTS

1. Remove two screws which hold the lower contact base (7) to the two guide spacers (2). The upper contact base, containing the magnet coil assembly (11), can now be separated from the lower contact assembly.

2. Remove the main spring (9), arc boxes (6), and plunger assembly (4).

3. Disassemble plunger assembly, and remove spring retainers holding the springs and main contacts in place. Remove movable contacts.

4. Remove stationary contacts by unscrewing the contact posts from the base of the magnet coil assembly.

5. Replace movable and stationary contacts, and reassemble in reverse order of disassembly.

REPLACEMENT OF BOTTOM-MOUNTED COIL CONTACTOR INTERLOCK ASSEMBLY

1. Remove the two screws holding interlock assembly to lower contact assembly, Fig. 8-19, and remove interlock assembly.

2. Install new interlock assembly.

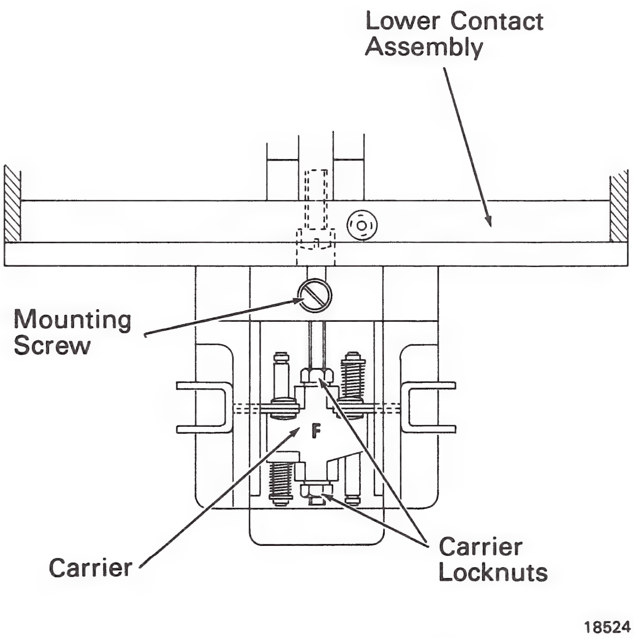


Fig.8-19 – Bottom-Mounted Coil, Interlock Assembly

3. Position the interlock carrier by adjusting the carrier locknuts so that interlocks make proper contact. Recheck interlock travel to ensure that the normally closed interlocks break before the normally open interlocks make.

4. Apply glyptol enamel to carrier locknuts after adjustment.

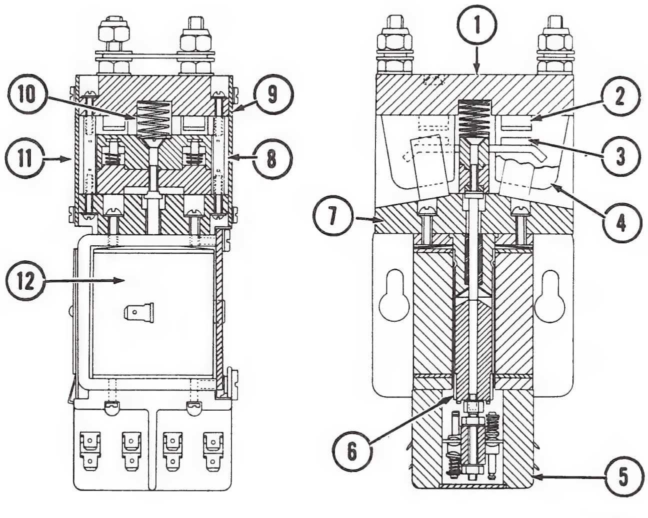
INSPECTION AND REPLACEMENT OF BATTERY FIELD CONTACTOR CONTACTS

1. Remove the front cover and the four screws holding the rear cover to the lower contact base, Fig. 8-15.

2. Check stationary and movable contacts. If movable contacts are worn to where 0.79 mm (1/32") or less alloy material remains, stationary and movable contacts should be replaced.

REPLACEMENT OF MOVABLE AND STATIONARY CONTACTS

1. Remove two screws which hold the lower contact base (7, Fig. 8-20) to the two guide spacers (8). The upper contact base (1), containing the magnet coil assembly (12), can now be separated from the lower contact assembly (7).



1. Upper Contact Base
2. Stationary Contact
3. Movable Contact
4. Arc Chute
5. Interlock Assembly
6. Plunger Assembly
7. Lower Contact Base
8. Guide Spacer
9. Rear Cover
10. Main Spring
11. Front Cover
12. Magnet Coil Assembly

Fig.8-20 – Bottom-Mounted Coil Contactor

2. Remove the main spring (10), arc chutes (4), and plunger assembly (6).

3. Disassemble plunger assembly (6), and remove spring retainer rings holding the springs and movable contacts in place. Remove movable contacts (3).

4. Remove stationary contacts (2) by unscrewing the contact posts from the base of the magnet coil assembly (12).

5. Install new movable and stationary contacts and reassemble in reverse order of disassembly.

REPLACEMENT OF BOTTOM-MOUNTED COIL CONTACTOR INTERLOCK ASSEMBLY

1. Remove the two screws holding interlock assembly to lower contact assembly, Fig. 8-21, and remove interlock assembly.

2. Install new interlock assembly.

3. Position the interlock carrier by adjusting the carrier locknuts so that interlocks make proper contact. Recheck interlock travel to ensure that the normally closed interlocks break before the normally open interlocks make.

4. Apply glyptol enamel to carrier locknuts after adjustment.

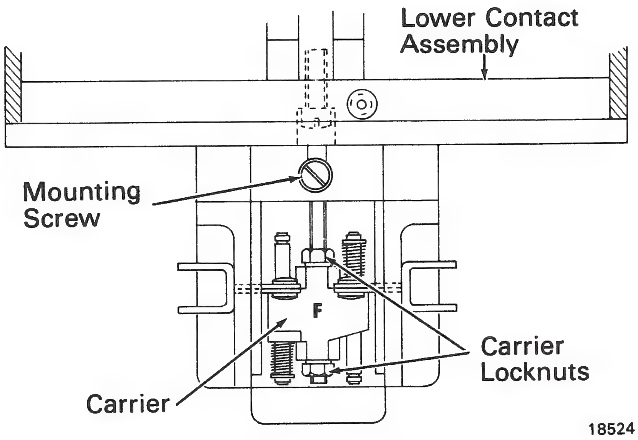


Fig.8-21 - Bottom-Mounted Coil Contactor Interlock Assembly

SERVICE DATA

SPECIFICATIONS

REFERENCES

Engine Starting And Generator Field Decay Contactors	M.I. 5300
Field Shunting And Load Test Transfer Contactors	M.I. 5408
Power Contactors	M.I. 5424
Transfer Switches – 8464113, 8464114, 8464116, 8464117, 8464118	M.I. 5426

POWER CONTACTOR 8461331

MAIN CONTACTS

Contact Rating	1000 Amps
Contact Pressure – new	4.1-4.5 kg (9-10 lbs.)
Contact Wear Allowance (each contact)	1.6 mm (1/16″)
Contact Minimum Opening – new	11.9 mm (15/32″)

INTERLOCK CONTACTS

Contact Lift, Short Wipe (at 2.4 mm [3/32″] deflection)	113 g (.25 lbs.)
Contact Lift, Long Wipe (at 6.33 mm [1/4″] deflection)	136 g (.30 lbs.)
Movable Contact Travel 6.33 mm	9.53 mm (.375″)
Contact Wear Allowance (total)	1.52 mm (.060″)
Contact Arrangement Interlock 8329110	
A-B, C-D	Closed
E-F, G-H	Open
Contact Arrangement Interlock 8332086	
A-B	Closed
C-D	Open
E-F, G-H	Open

MAGNET COIL

Resistance (at 20° C)	120 ohms (±10%)

OPERATION

Working Voltage (continuous)	74 VDC
Pickup (at 20° C)	48 VDC
Dropout (at 20° C)	5-28 VDC

HI-POT

	60 Hz, 1 Minute
Magnet Coil To Mounting Magnet Coil To Main Contacts Main Contact To Mounting Main Contact To Interlock Contacts Between Open Main Contacts Interlock Contacts To Mounting	2400 V RMS

TRANSFER SWITCH 8464117

MAIN CONTACTS

Contact Rating	1000 Amps
Contact Pressure (min. per pole)	2.27 kg (5 lbs.)
Wipe Gap	1.14 ± 0.38 mm (.045″ ± .015″)
Contact Wear Allowance (total)	2.4 mm (3/32″)
Contact Gap (energized or de-energized)	6.3 mm (1/4″)

INTERLOCK CONTACTS

Contact Lift, Short Wipe (at 2.4 mm [3/32″] deflection)	113 g (.25 lbs.)
Contact Lift, Long Wipe (at 6.33 mm [1/4″] deflection)	136 g (.30 lbs.)
Movable Contact Travel	9.52 mm (.375″)
Contact Wear Allowance (total)	1.52 mm (.060″)
Contact Arrangement	
A-B	Open
C-D	Closed
E-F, G-H	Open

MAGNET COIL

Resistance (at 20° C)	19.8 ohms

OPERATION

Working Voltage (intermittent)	74 VDC
Pickup (at 20° C)	48 VDC
Dropout (at 20° C)	5-28 VDC

ECONOMIZING RESISTOR

Resistance (at 20° C)	75 ohms (±5%)
Wattage	55 watts

MOTOR CUTOUT ASSEMBLY (Transfer Switch 8464118 Only)

Coil Resistance (at 20° C)	190 ohms
Coil Pickup (at 20° C)	48 VDC
Coil Rating	74 VDC
Microswitch Contact Arrangement	
Switch De-energized	
1-2	Open
3-4	Closed
Switch Energized	
1-2	Closed
3-4	Open

HI-POT

	60 Hz, 1 Minute
Magnet Coil To Mounting	600 V RMS
Magnet Coil To Contacts Main Contacts To Mounting Main Contacts To Interlock Contacts Interlock Contacts To Mounting	2400 V RMS
Motor Cutout (Transfer Switch 8464118 Only) Coil To Mounting Microswitch Terminals To Mounting	600 V RMS

FIELD SHUNTING CONTACTOR 8358407

MAIN CONTACTS

Contact Rating	500 Amps
Contact Wear Allowance (total)	1.6 mm (1/16")
Contact Opening (minimum)	6.3 mm (1/4")
Contact Overtravel	3.2 mm (1/8")

INTERLOCK CONTACTS

Contact Rating	10 Amps
Normal Lift	2.4 mm (3/32")
Opening At Stop	4.8 mm (3/16")
Total Wear (maximum)	1.6 mm (1/16")
Contact Arrangement Interlock 8329574	
A-B	Closed
C-D, E-F, G-H	Open

MAGNET COIL

Resistance (at 20° C)	125 ohms (±5%)

OPERATION

Working Voltage (continuous)	74 VDC
Pickup (at 20° C)	48 VDC
Dropout (at 20° C)	5-28 VDC

HI-POT

	60 Hz, 1 Minute
Magnet Coil To Mounting	600 V RMS
Magnet Coil To Interlock Contacts Interlock Contacts To Mounting Main Contacts To Mounting	2400 V RMS

STARTING CONTACTOR 8415485

MAIN CONTACTS

Contact Rating	1000 Amps
Contact Wipe	4.0 mm (5/32")
Contact Gap	2.4 mm (3/32")

INTERLOCK CONTACTS

Contact Rating	3 Amps
Contact Arrangement	
A	Open
B	Closed

MAGNET COIL

Resistance (at 20° C)	23.3 ohms (±10%)

OPERATION

Working Voltage (intermittent, 2 minute on, 2 minute off)	74 VDC
Pickup (maximum)	36 VDC
Dropout	3-16 VDC

HI-POT

	60 Hz, 1 Minute
Magnet Coil To Mounting	600 V RMS
Magnet Coil To Main Contacts Main Contacts To Mounting Interlock Contacts To Mounting Interlock Contacts To Interlock Contacts	2400 V RMS

BATTERY FIELD CONTACTOR 8254056

MAIN CONTACTS

Contact Rating	60 Amps
Contact Wear Allowance	0.8 mm (1/32″)
Contact Wipe	1.6 mm (1/16″)
Contact Gap	2.8 mm (7/64″)

INTERLOCK CONTACTS

Contact Rating	10 Amps
Contact Wipe	0.8 mm (1/32″)
Contact Arrangement	
A-B, C-D	Open
E-F, G-H	Closed

MAGNET COIL

Resistance (at 20° C)	360 ohms (±10%)

OPERATION

Working Voltage	74 VDC
Pickup	48 VDC
Dropout	5-28 VDC

HI-POT

	60 Hz, 1 Minute
Magnet Coil To Mounting Magnet Coil To Contacts Main Contacts To Mounting Interlock Contacts To Mounting Interlock Contacts To Interlock Contacts	600 V RMS

LOAD TEST AND HORSEPOWER STANDARDIZATION

INTRODUCTION

This section contains procedures for load test and horsepower calculation and standardization of the MP15DC locomotive. Accurate and standardized horsepower data can be used to evaluate performance of the engine and auxiliary equipment and to indicate possible malfunction or excessive horsepower output. Correction of malfunctions will improve engine performance. Operation at correct horsepower will deter abnormal wear rates.

Service Data pages provide the following information.

1. References to drawings and other publications.
2. Routine maintenance parts and equipment.
3. Specifications covering components and circuits.
4. Horsepower and loading resistance graphs, and horsepower correction factors.

PREPARATION FOR LOAD TEST

1. Stop the diesel engine and remove the starting fuse.
2. Check that fuel tank contains sufficient fuel (minimum 568 litres [150 gallons]) for the period of the load test (about 90 minutes). Fuel should be in accordance with specifications listed in M.I. 1750.
3. Check oil level at:
    a. Engine oil pan.
    b. Air compressor.
    c. Governor.
4. Check that coolant level is at the STOP/FULL mark on the water tank sight glass gauge.
5. Perform an engine air box inspection. Check condition of piston rings and cylinder walls.
6. Suspend a thermometer, shielded from the sun, to measure ambient air temperature.

NOTE

All engineroom doors are to remain closed during the testing.

7. Remove the plug in the engine mounted fuel filter and install a dial thermometer to read fuel oil temperature, Fig. 9-1.

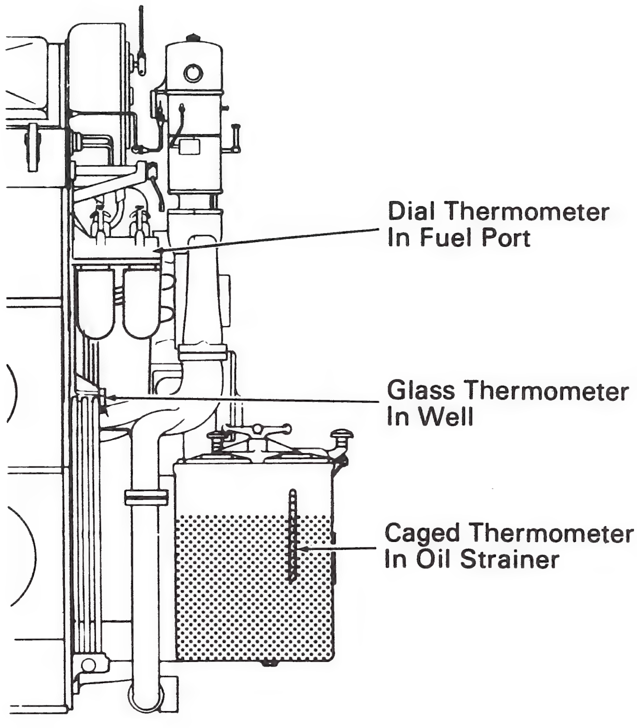


Fig.9-1 — Thermometer Placement For Load Testing

8. Fill the thermometer well located in the water pump discharge elbow with oil. Place a glass thermometer in the well to measure engine water inlet temperature. See Fig. 9-1.

9. Suspend a caged glass thermometer below the oil level in the lube oil strainer housing. This will measure engine oil inlet temperature. See Fig. 9-1.

TEST SETUP FOR LOAD TESTING ON A LOAD BOX

CAUTION

Ensure that all connections are made securely to prevent the possibility of loose connections and resultant damage to cables and shunt.

1. Connect two 775/24 cables to main generator GP bus. Connect other ends of cables to load box positive.

NOTE

Do not complete the connection specified in Step 2 before starting the engine unless the load box is equipped with a switch to isolate the load while starting the engine.

2. Connect two 775/24 cables to main generator GN bus terminal. Connect other ends of cables to load box.

3. Connect a 0-50 or DC millivolt meter with 1/2 of 1 percent accuracy to load test shunt + and - on test panel (TP1 to TP2).

4. Set TEST SWITCH on TEST PANEL to LOAD TEST.

5. Connect a 0-1500 DC voltmeter to indicate main generator voltage (GP positive to GN negative on test panel).

6. Select loading resistance in accordance with loading graph provided in Service Data.

LOAD THE UNIT

1. Replace the starting fuse. Start the diesel engine and set up the controls for operation under power.

2. Place throttle in Run 1 and check the following:

   a. Engine oil pressure satisfactory.

   b. No fuel, oil, or water leaks.

   c. Compressor unloaded.

   d. Load box blower operating.

   e. Generator volts and amperes registering.

3. Advance throttle to Run 3 and allow engine temperature to reach at least 55° C (130° F) before full loading.

4. Advance throttle one step at a time to full engine speed and load. When full speed and load are obtained, check radiator fan and shutter operation. A test button is located on each engine temperature switch.

5. With throttle at Run 8, check that the load regulator is at a balance point and is not at maximum field position.

6. Connect a normally open pushbutton switch between F1 of MR and F of BF. Then close the switch. Load regulator should move quickly to the minimum field position. After releasing the test switch the load regulator should return to a balance point.

7. Close all engineroom doors and all cabinet doors possible. Allow engine to run at full load until conditions stabilize. (About 1/2 hour if horsepower only is being checked, and at least 60 minutes if oil cooler performance or some other engine condition is being checked.) The radiator inlet area can be partially blocked if closer control of temperature is required for stability.

8. Check engine water temperature periodically until there is no difference between one temperature reading and another taken 15 minutes later.

9. When stability of conditions is verified, observe and record the following temperature readings.

   a. Fuel temperature.

   b. Water temperature at the water pump outlet.

   c. Engine oil temperature at the strainer.

   d. Ambient air temperature at the radiator inlet.

10. Take a second set of temperature readings 15 minutes later and a third set 15 minutes after the second.

CALCULATION AND HORSEPOWER STANDARDIZATION

1. From the observations, calculate the corrected brake horsepower, using the formulas, correction factors, and auxiliary horsepower values that appear in the Service Data.

2. If the total horsepower adjusted to standard conditions is not as specified on the Service Data pages, check rack settings, injector timing, valve timing, governor settings, injector calibration, air filter cleanliness, power assembly condition, and generator excitation to find the reason for the horsepower discrepancy.

3. If engine lube oil inlet temperature is higher than the maximum indicated on the Service Data graph, the lube oil cooler should be cleaned and inspected.

SERVICE DATA

LOAD TEST AND HORSEPOWER STANDARDIZATION

REFERENCES

Locomotive "Charts And Graphs" drawing, which includes setting values for systems and components, and the locomotive "Wiring Running List," which includes an electrical parts list, is referenced in the lower right corner of the locomotive wiring diagram.

Engine Maintenance Manual

Lube Oil Coolers .... M.I. 927
Lubricating Oil Cooler Service Limits .... M.I. 928

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

Volt-Millivolt-Milliammeter (2 Required) 8218499
1100/0.0201 Cable (444, 440 Circular Mils) ERP-HY Insulation
  Ethylene Propylene Diene With Hypalon Jacket 8421211
    Terminal Lugs For 1100/0.0201 Cable 8118062
775/24 Cable (313,000 Circular Mils) Ethylene
  Propylene Diene With Hypalon Jacket 8421210
    Terminal Lugs For 775/24 Cable 8118061
550/24 Cable (220,000 Circular Mils)
  Ethylene Propylene Diene With Hypalon Jacket 8421209
    Terminal Lugs For 550/24 Cable Drilled To Accept 3/8" Bolt Or Stud 8197509
    Blank 8188060

TABLE OF CABLE RECOMMENDATIONS* FOR LOAD TESTING DUTY

Size	Amperes
550/24	660
775/24	810
1100/24	1020

*Based on four conductors 13 mm (1/2") spacing in open air to keep temperature within 120° C rise.

THERMOMETERS REQUIRED

Dial Indicating Thermometer 0° - 70° C (0° - 150° F) Equipped With 1/4" N.P.T. Threaded Stud.

Glass Thermometer 0° - 70° C (0° - 150° F).

Glass Thermometer 30° - 120° C (100° - 250° F) Bulb 6 mm (1/4") Maximum Diameter.

Caged Glass Thermometer 30° - 120° C (100° - 250° F).

SERVICE DATA (CONT'D)

SPECIFICATIONS

Model MP15DC

Governor Rack	Engine RPM	Total Power Adjusted Standard Conditions
0.87	900-908	1120 kW (1500 HP) Nominal

Formulas: Input To Generator = Generator Horsepower = $\dfrac{\text{Main Gen. Volts x Main Gen. Amps}}{\text{Watts-To-Horsepower Conversion Factor}\dagger}$

†A factor of 700 is recommended.

Total Horsepower Adjusted To Standard Conditions = $\dfrac{\text{Gen. HP + Auxiliary HP}}{\text{A x B x C x D}}$

Where in the formula —

A —Is the correction factor for air temperature.
(Standard is 15.5 degrees C [60 degrees F].)

NOTE
See correction factors chart for difference between blower inlet temperature and ambient.

B — Is the correction factor for altitude.
(Standard at Sea level is 29.9 inches Hg. — 1 bar)

C —Is the correction factor for fuel density.
(Standard is 0.845 specific gravity.)

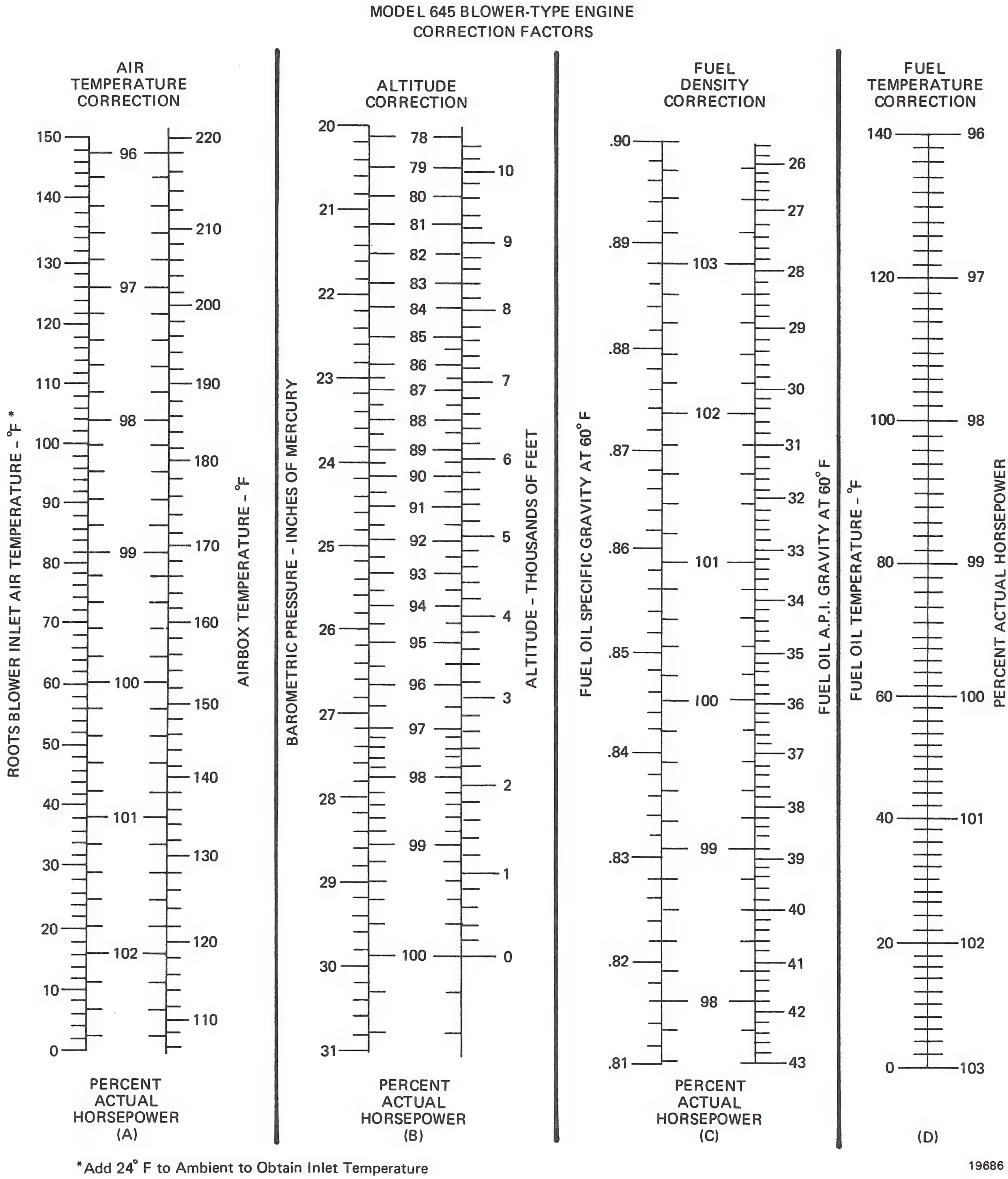
D —Is the correction factor for fuel temperature.
(Standard is 15.5 degrees C [60 degrees F].)

Reference to the table of correction factors for A, B, C, and D above.

TABLE OF AUXILIARY HORSEPOWER	HP	kW
Auxiliary Generator	7.0	5.2
*Generator And Traction Motor Blower	31.0	23.1
*Cooling Fan (Shutters Open)	76.0	56.7
Compressor (Unloaded)	15.0	11.2
Total Auxiliary Horsepower **	129.0	96.2

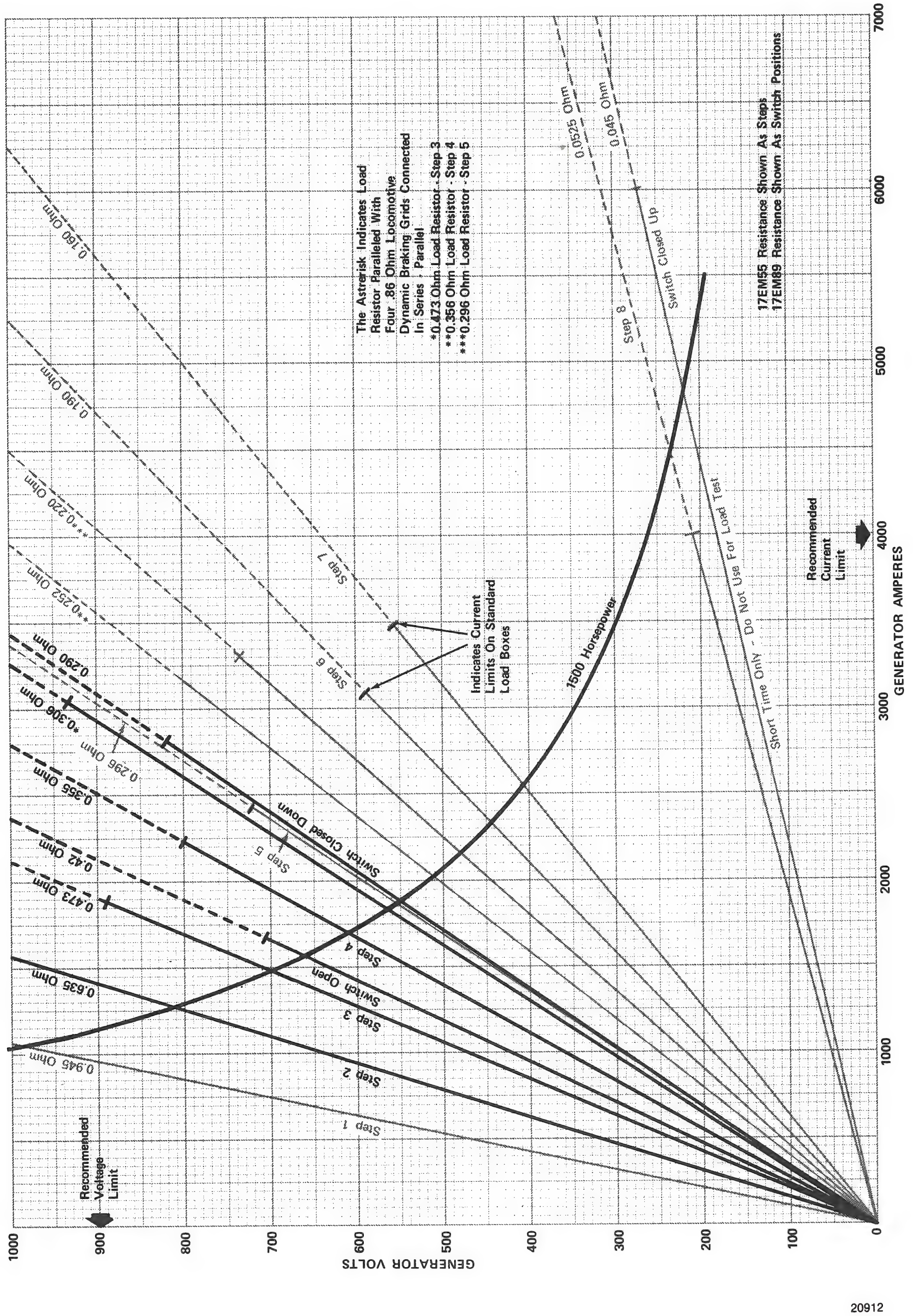
*@ 0.070 Lb/Ft³ Ambient Air Density.
**Add 7.5 kW (10 HP) for inertial filter blower on units so equipped.

SERVICE DATA (CONT'D)
MP15DC LOCOMOTIVE
MODEL 645 BLOWER-TYPE ENGINE
CORRECTION FACTORS



Horsepower Correction Factors Chart

SERVICE DATA (CONT'D)



20912

1500 HP Generator Loading Graph (17EM55 And 89 Loading Resistor Boxes)

WHEEL SLIP DETECTION AND CONTROL SYSTEM TESTING AND SETTING

INTRODUCTION

The purpose of this section is to provide procedures for testing and setting the wheel slip control system. Section 7C of this manual describes the system.

Values for calibration of circuits are provided in this section and are also provided on the "Charts And Graphs" drawing, the number of which is referenced in the lower right corner of the applicable locomotive wiring diagram.

Service Data pages are included with this instruction. They provide the following:

1. References to drawings and other publications relating to equipment and procedures covered in this instruction.
2. A list of routine maintenance parts and equipment recommended for use with the procedures given in this instruction.
3. Specifications covering components.

GENERAL BRIDGE CIRCUIT CHECK, Fig. 10-1

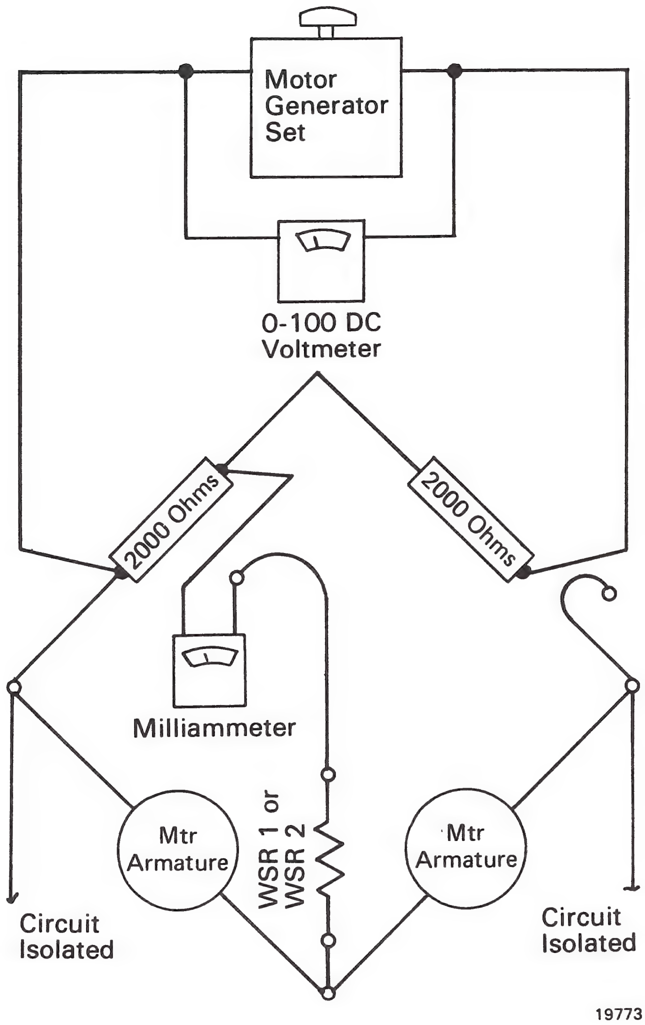


Fig.10-1 – Wheel Slip Bridge Circuit, General Test Setup

1. Place the isolation switch in ISOLATE position, and remove the battery field fuse. Allow the diesel engine to run to secure normal vibrations.
2. Disconnect a wire from one of the 200 ohm bridge resistors as shown in Fig. 10-1.
3. Connect the output from a motor generator set to the 2000 ohm bridge resistors as indicated in Fig. 10-1. The positive lead may be at either of the resistors.
4. Disconnect the wire leading from a 2000 ohm resistor to the wheel slip relay, and connect a 0-30 milliammeter as indicated in Fig. 10-1.
5. Connect a 0-100 DC voltmeter to read MG set output voltage.
6. Connect a 6 watt 74 volt test lamp to indicate wheel slip relay pickup. From the "B" terminal of the wheel slip bridge relay under test to a convenient negative. The test light will go on when the wheel slip bridge relay picks up.

7. Make certain that the battery field fuse is removed, then set the locomotive controls for power and open the throttle.

8. Connect the motor generator set input leads. (At the back positive STP terminal and the front negative BN terminal of the GS contactor.)

9. Slowly apply MG set voltage. The WS relay should pick up at 18.3 to 19.7 milliamperes and 73 to 83 volts. Incorrect current at pickup indicates a faulty relay. Incorrect voltage at pickup indicates a fault in the bridge circuit.

10. Return circuit to normal standby condition after completion of checks.

WHEEL SLIP RELAY OPERATIONAL CHECK

The through-cable wheel slip relay WSR is used to drop the battery field contactor and provide a wheel slip light indication in case motor differential current rises to about 140 to 160 amperes.

A two-level wheel slip control system is available upon request from the customer. This two-level system uses a wheel creep relay WCR and a wheel slip relay WSR.

The wheel creep relay WCR is used to energize time delay sanding relay TDS in case motor differential current rises to about 115 to 135 amperes. Pickup of TDS initiates sanding to increase adhesion for correction of a minor wheel slip. If the wheel slip condition persists, WSR picks up at 140 to 160 amperes. Pickup of WSR drops the battery field contactor and provides a wheel slip light indication.

WSR TEST PROCEDURES

The WSR relay operates on differential current. However, a voltage coil on the relay frame may be used to perform an operational test. 17 to 19 milliamperes through the voltage coil is equivalent to 140 to 160 amperes of motor differential current. Test procedures are simplified by using the voltage coil for the operational test. Therefore, the voltage coil is used in the following test procedures.

1. Place the isolation switch to isolate position and remove the main generator battery field fuse. Allow the diesel engine to run to obtain normal vibration.

2. Connect a 64 volt 6 watt test light between terminal D of WSR and any convenient negative. The test light will go on when WSR picks up and will go out when WSR drops out.

3. Connect one end of a 100 ohm 100 watt potentiometer to any convenient negative, then set the potentiometer wiper arm to this negative terminal. Connect the other end of the potentiometer to any convenient +74 VDC, Fig. 10-2.

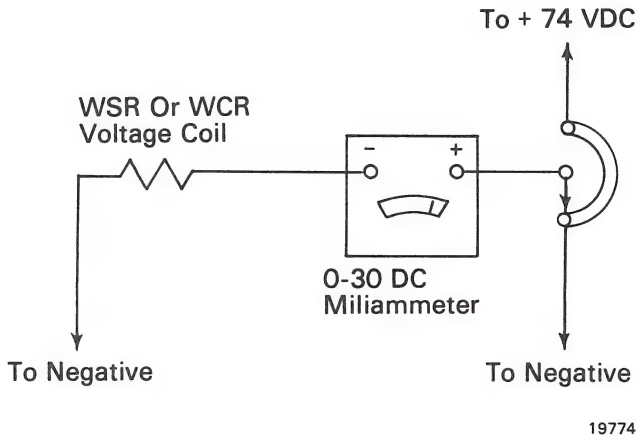


Fig.10-2 – WSR And WCR Test Setup

4. Connect potentiometer wiper arm to the positive terminal of 0-30 DC millammeter.

5. Connect one terminal of WSR voltage coil to negative terminal of the 0-30 DC milliammeter, then connect the other terminal of WSR voltage coil to any convenient negative.

6. Slowly adjust the potentiometer to apply approximately 15 milliamperes of current through the WSR voltage coil, then very slowly increase the current to pick up WSR as indicated by the test light. WSR should pick up at 17 to 19 milliamperes.

7. After WSR pickup, very slowly decrease current through WSR voltage coil until WSR drops out as indicated by the test light. WSR should drop out at 9 to 12 milliamperes.

NOTE

If WSR pickup and dropout are not as specified in Steps 6 and 7, refer to M.I. 5353 for maintenance procedures of WSR.

8. Adjust potentiometer for minimum current then disconnect WSR voltage coil from the test setup.

NOTE

If unit is equipped with a WCR relay, proceed to WCR test procedures. If unit is not equipped with WCR relay, disconnect the 100 ohm 100 watt potentiometer, 0-30 DC milliammeter, and the test light, then return the circuits, switches, and controls to normal standby condition.

WCR TEST PROCEDURES

1. Ensure that the isolation switch is set to isolated position and that the main generator battery field fuse is removed. Allow the diesel engine to run to obtain normal vibration.

2. Connect a 64 volt 6 watt test light between terminal D of WCR relay and any convenient negative. The test light will go on when WCR picks up and will go out when WCR drops out.

3. Connect a 64 volt 6 watt test light between the right B terminal of TDS and any convenient negative. This test light will go on when TDS picks up and will go out when TDS drops out.

4. Connect the 100 ohm 100 watt potentiometer, the 0-30 DC milliammeter, and the WCR voltage coil as shown in Fig. 10-2.

5. Slowly adjust the potentiometer to apply approximately 10 milliamperes through the WCR voltage coil, then very slowly increase the current to pick up WCR as indicated by the test light connected at terminal D of WCR. WCR should pick up at 13.5 to 15.5 milliamperes.

NOTE

TDS should pick up immediately after WCR pickup. The test light connected to the right B terminal of TDS goes on when TDS picks up.

6. After WCR pickup, very slowly decrease current through WCR voltage coil until WCR drops out as indicated by the test light connected at terminal D of WCR. WCR should drop out at 8 to 10 milliamperes. TDS should drop out within 5 to 8 seconds after WCR drop out.

NOTE

If WCR pickup and dropout are not as specified in Steps 5 and 6 refer to M.I. 5353 for WCR maintenance procedures. If TDS does not drop out as specified in Step 6, refer to M.I. 5352 for TDS maintenance procedures.

TEST SETUP DISCONNECT

1. Adjust the 100 ohm 100 watt potentiometer for minimum current, then disconnect the potentiometer, 0-30 milliammeter, and the wheel slip relay voltage coil.

2. Disconnect the 64 volt 6 watt test lights.

3. Replace the main generator battery field fuse, then return all circuits, switches, and controls to normal standby condition.

SERVICE DATA

WHEEL SLIP DETECTION AND CONTROL SYSTEM

REFERENCES

MP15DC Charts And Graphs Drawing WD00158

The locomotive "Wiring Running List," which includes an electrical parts list, is referenced in the lower right corner of the locomotive wiring diagram.

Through-Cable Wheel Slip Relay . . . . M.I. 5353

Time Delay Relays (TDS on special order) . . . . M.I. 5352

Volt-Millivolt-Milliammeter 8218499

Ohmmeter 8210990

Motor Generator Set, 64 Volt DC Input, 1200 Volt DC Output 8233558

Test Lamp, 6 Watt 64-125 VAC/DC
(2.4 m [8 ft.] leads – alligator clips) 8279561

Manually operated 100 ohm 100 watt tapered
wire wound type load regulator rheostat 8330980
or 8406436

Jumper wires equipped with faston tabs.

Jumper wires equipped with alligator clips.

SPECIFICATIONS

Relay, Time Delay (TDS) 8276598
Coil Resistance . . . . 417 Ohms ± 10%
Pickup . . . . 48 Volts DC Maximum
Dropout . . . . Between 5 and 28 Volts DC
Timing Range . . . . 0.2 seconds to 3.0 minutes
See the "Charts And Graphs" drawing for specific relay timing.

Relay (Through-Cable Type) WSR 8172591
Contacts –
Arrangement . . . . 1 NO - 1 NC (With Overlap)
Rating . . . . 2.5 Amperes

Coil Resistance . . . . 542 Ohms @ 20° C

Value For Voltage Coil Operation
Coil Pickup . . . . 17 to 19 Milliamperes
Coil Dropout . . . . 9 to 12 Milliamperes

Value For Through-Cable Operation
Pickup On Through-Cable Differential Current
One Turn Through Relay Frame . . . . 140 to 160 Amperes
Two Turns Through Relay Frame . . . . 68 to 82 Amperes
Dropout . . . . 55% of pickup (Minimum)

Relay (Through-Cable Type) WCR 8191734
Contacts –
Arrangement . . . . 1 NO - 1 NC (With no overlap)
Rating . . . . 2.5 Amperes
Coil Resistance . . . . 542 Ohms @ 20° C

Value For Voltage Coil Operation
Coil Pickup . . . . 13.5 to 15.5 Milliamperes
Coil Dropout . . . . 8.0 to 10.0 Milliamperes

Value For Through-Cable Operation
Pickup On Through-Cable Differential Current
One turn through relay frame . . . . 115 to 135 Amperes
Two turns through relay frame . . . . 56 to 68 Amperes
Dropout . . . . 55% of pickup (Minimum)

Relay (Voltage-Type) WSR1 and WSR2 8454412
A-B Normally Open
C-D Normally Closed

Coil E-F . . . . 1050 ± 20 Ohms

Relay Operating Values
Pickup . . . . 0.0183 to 0.0197 Amperes
Dropout . . . . 60% of pickup value (Minimum)

SECTION

11

ELECTRO-MOTIVE

LOCOMOTIVE SERVICE MANUAL

HIGH POTENTIAL TESTS FOR LOCOMOTIVES IN SERVICE

INTRODUCTION

Locomotive electrical circuits and equipment are sufficiently well insulated to withstand potentials far in excess of those experienced in normal operation. This insulation dielectric strength should, however, be periodically checked to verify that this margin of safety remains in existence. High potential tests provide the means for making this check.

During high potential testing, wiring and equipment are subjected to voltages or potentials that are higher than normal. These potentials are applied for specific periods of time. For the circuit to qualify, there must be no breakdown of insulation to ground. The dielectric strength of the insulation is then considered satisfactory. On the other hand, a breakdown to ground indicates the need for improved insulation on the circuit or device tested.

This section provides a guide for high potential testing of locomotive wiring and equipment. The Service Data page provided with this instruction indicates recommended procedures to prevent accidental destruction of circuit components that may be unable to withstand the test potential should a fault exist in the tested circuit.

TEST EQUIPMENT

It is of the utmost importance that a reliable high potential testing machine is used. The machine should be in verified good condition so that adequate tests can be made safely, without unnecessarily overstressing insulation during testing.

The machine to be used for high potential testing should have the following characteristics.

1. Wave Form

   The voltage specified for high potential testing are root-mean-square voltages, and the wave form should be such as to have a limit of 5% third harmonic. This limitation fixes the peak voltage for any RMS voltage. The wave form may be influenced by the capacity of the testing apparatus relative to the size of the equipment being tested.

2. Surges

   The means employed to change voltage on the primary must be such that harmful surges do not occur.

3. Regulation

   The secondary voltage drop should not exceed 20% under actual test conditions.

SAFETY PRECAUTIONS

1. Whenever possible high potential tests should be performed by one man. All others should be kept off the locomotive and away from the test area.

2. A thorough knowledge of the circuit equipment, and procedures involved is essential. Extreme care should be taken to make certain that tests are properly made. Before making any high potential tests, a 500 voltage megger test should be applied for one minute to determine the condition of the circuit. Circuits containing static electronic components such as transistors and silicon rectifiers must be disconnected or shorted during the tests.

3. To prevent dangerous overvoltage surges, test electrodes must be firmly connected to the circuit or item before the voltage is applied. Similarly, the voltage should be removed before the electrodes are removed.

4. After the tester has been removed from the item being tested, clear the item of possible residual voltage by discharging to ground with a suitable insulated conductor.

TEST OF LOCOMOTIVES IN SERVICE

To comply with established regulations, it is necessary to perform high potential tests on locomotive high voltage (DC) circuits. It is also good practice to megger the low voltage control circuits. Preparation for tests should be made as indicated on the Service Data page that follows this instruction.

1. High Voltage DC Circuits

   High voltage circuits include all equipment and wiring connected to the output of the main generator, plus the dynamic brake grid resistors and circuits (where used).

2. Low Voltage (DC) Circuits

   The low voltage circuits include all control, equipment, and wiring connected to the locomotive auxiliary generator and storage battery. High potential tests are not required for low voltage circuits and equipment, however, it is good practice to check insulation resistance to ground. This may be done using a megohm-meter (500 VDC maximum) after grounding the high voltage DC circuits. A reading of one megohm or better indicates satisfactory insulation resistance to ground. Perform protective steps indicated on the Service Data page before performing the checks.

TEST PROCEDURE

The preferable time to perform high potential tests is right after a locomotive has completed a run. In such instances, the equipment is warm and dry, thus eliminating the possibility of moisture that might be present in units that have been shut down for an extended period of time.

Prior to making a high potential test, the circuit insulation resistance should be checked with a suitable megohmmeter. Readings of less than one megohm should be viewed with suspicion, as applying a high potential test in such instances may cause a breakdown of the insulation. To reduce risk of this possibility, the cause of low megohmmeter readings should be determined and corrected. This may be done by reducing the complete circuit concerned into individual circuits which are then isolated and check separately. In this way, the circuit portion or equipment causing the low reading can be found. Correction may often be made by thorough cleaning and drying of the affected areas.

Refer to the Service Data page provided with this instruction for data regarding protective procedures before making high potential tests.

When preparations have been completed, apply the high potential test as follows:

1. Make certain that the tester is not connected to the power supply, the control knob is set at zero (0), and the control switch is off.
2. Connect one electrode firmly in contact with the insulated conductor of the circuit being tested. Refer to wiring diagram for suitable points of connection.
3. Connect the other electrode firmly in contact with ground, such as locomotive underframe.
4. Make certain that circuits other than the one being tested have been isolated and grounded.
5. Connect the high potential tester to a power supply and turn the control switch on.
6. Press ON button firmly down, and while holding in this position, slowly turn control knob to specified test voltage.
7. After applying specified voltage for the required period of time, and while still holding the ON button down, slowly turn the control knob back to zero (0).
8. Release ON button and place control switch OFF.
9. Discharge tested circuit to ground before removing electrodes.
10. Repeat the preceding tests for other circuits involved in the test.

SERVICE DATA

HIGH POTENTIAL TESTS FOR LOCOMOTIVES IN SERVICE

High Voltage DC Circuits . . . . 1050 Volts RMS For 1 Minute
Maximum Output Current - 330 Milliamperes

Low Voltage DC Circuits . . . . Megohmmeter Test Only
(500 Volt DC Maximum Megger)

PRELIMINARY PREPARATION

Before making high potential checks of the high voltage circuits, make a preliminary check of circuit condition with a 500 or 1000 volt megohmmeter. These megohmmeter readings should be recorded in a locomotive maintenance log. The readings are most useful when compared to previous readings. The low voltage control circuits may be checked at the same time, using a maximum 500 volt megohmmeter.

Before starting the checks, take the following protective measures.

1. Open main battery switch.
2. Open the ground relay cutout switch.
3. Place all circuit breakers in the ON position.
4. Close all control switches.
5. Pull out all circuit modules half way to fully disconnect the circuit modules from locomotive circuitry.
6. Connect jumper wires to interconnect terminals 1, 2, 3, 5, and 6 of battery field SCR.
7. Unbolt the GN1 and GN2 cables at the shunt panel, Fig. 6-9, and insulate between the cable lugs and the shunt panel.
8. Lift all generator negative brushes so the minimum distance to the commutator is that of the brush holder itself.
9. Connect the generator negative bus to ground using No. 10 to No. 14 flexible wire with clips.
10. Connect the generator negative bus to a negative brush holder using No. 10 to No. 14 flexible wire with clips.
11. Jumper positive to negative at the battery charging rectifier CRBC.
12. At main generator output, jumper all positive and negative buses together.
13. Disconnect or jumper out any electronic equipment such as radio, train control, speed indicator, automatic reset devices, and fault counters.
14. High Voltage DC Circuits

    Ground the low voltage DC circuits. Perform high potential tests on high voltage DC circuits and equipment. Reference locomotive schematic diagram.

15. Low Voltage DC Control Circuits

Remove ground from the low voltage DC circuits. Perform megohmmeter check on low voltage DC circuits and equipment, including the engine cranking motors.

NOTE

On units equipped with face plate type load regulators, disconnect the load regulator during megohmmeter checks to avoid misleading low readings. A reading of 25,000 ohms between the load regulator circuits and its case is considered acceptable.

After high potential tests have been completed perform Steps 16 through 18.

16. Remove all jumper wires. Refer to procedures for applying jumpers as a check list to ensure that all jumpers have been removed.
17. Install negative brushes in their holders and reconnect the GN1 and GN2 cables to the shunt panel.
18. Return controls and switches to normal standby condition.

MP15DC LOCOMOTIVE